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FACTORS INFLUENCING THE EFFICACY OF HUMAN EFFIGIES IN DETERRING WATERFOWL FROM POLLUTED PONDS

by

© JOHN ROBERT GULLEY

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled FACTORS INFLUENCING THE EFFICACY OF HUMAN EFFIGIES IN DETERRING WATERFOWL FROM POLLUTED PONDS submitted by JOHN ROBERT GULLEY in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in ZOOLOGY.

ABSTRACT

In 1977 and 1978, the effectiveness of a waterfowl deterrent, in the form of a human effigy, was tested on a tailings pond that received aqueous and bituminous effluent from a tarsands extraction plant near Fort McMurray, Alberta. In 1979, a means of lighting the effigy at night was added to the deterrent system because of the belief that birds were entering the pond during darkness. The device chosen was a revolving beacon mounted on a pumphouse that floated on the surface of the tailings pond. The effectiveness of the system was tested through a comparison of numbers of waterfowl dying in the pond each year relative to the mean numbers of waterfowl recorded annually in the vicinity. Results indicated that factors in addition to the presence of the deterrent system and the mean number of waterfowl in the area were also important. The number of days below the mean temperature of April and May, the number of days of measurable precipitation, and the amounts of precipitation during June-July and August-October were all positively correlated with kill rates. Despite these factors, support is presented for the effectiveness of human effigies in deterring waterfowl from entering tailings ponds. Unusual circumstances during 1979 precluded evaluation of the effectiveness of the night-lighting system on a full year basis, however, there were indications that during the summer and autumn it increased the effectiveness of the deterrent system.

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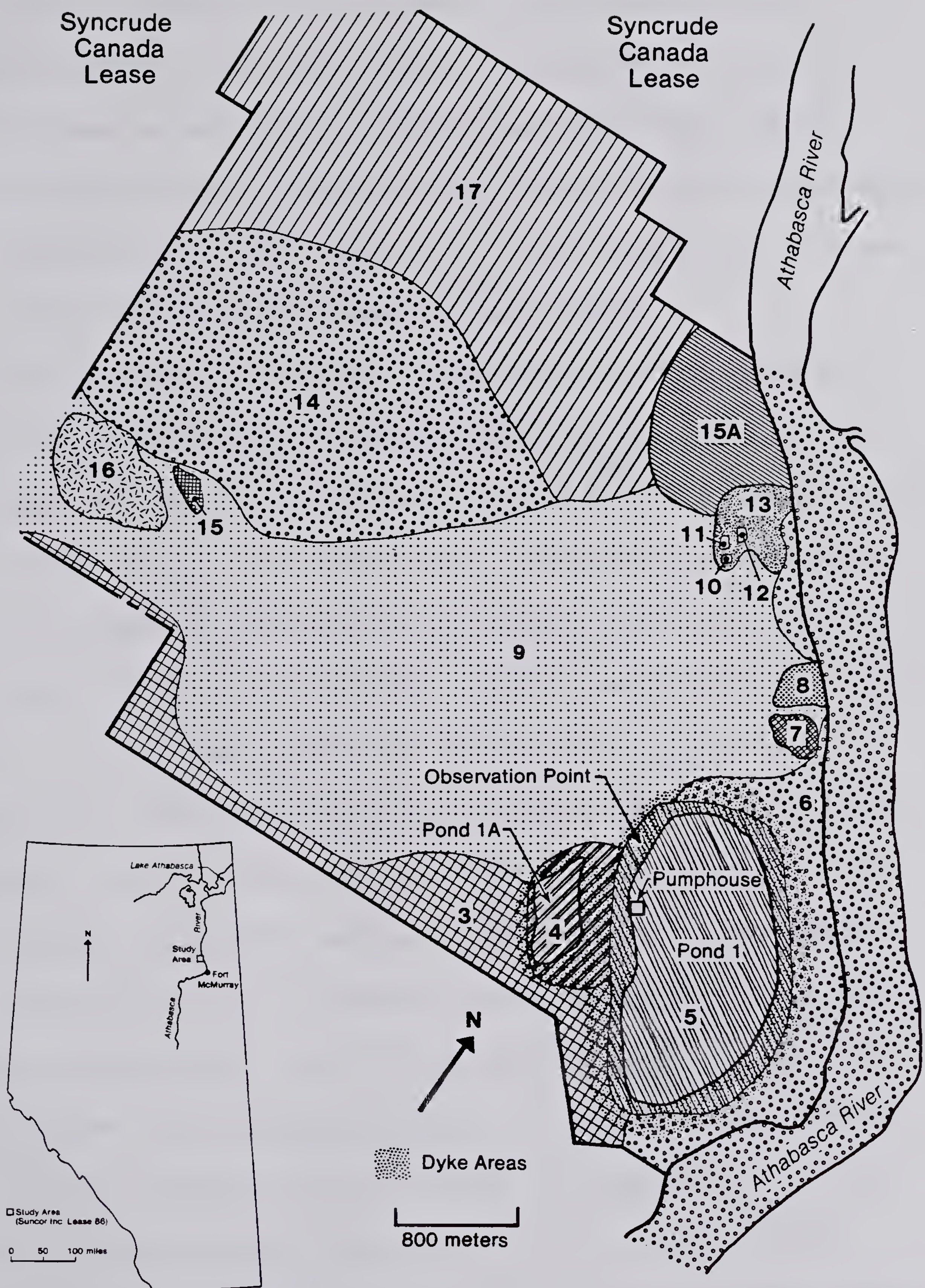
I. INTRODUCTION

Commercial exploitation of tarsand deposits in northeastern Alberta began in 1967 following completion of the Suncor Inc. (formerly Great Canadian Oil Sands Ltd.) extraction plant north of Fort McMurray (Fitzgerald 1978)(Fig. 1). In 1978, Syncrude Canada Ltd. commenced operations on a contiguous area north and west of Suncor. Both extraction plants use the Clark hot water process for separating bitumen (heavy oil) from the tarsand (Trost 1975). Tailings, a waste product of this process containing some bitumen, sand, fine mineral particles, water, caustic soda, and other extraction chemicals, is pumped as a hot fluid slurry into storage facilities known as tailings ponds (Intercontinental Engineering 1973). These ponds function not only as waste disposal areas but also as water clarification basins from which aqueous materials may be recycled into the extraction process (Trost 1975). Because the ponds receive heated slurry, they remain ice free longer in the autumn and become ice free earlier in the spring than do natural water bodies in the same region (Boag et al. 1975).

The bitumen fraction of the tailings floats on the surface of the tailings pond for a variable period of time ranging from hours to days, depending mainly upon the prevailing weather conditions. This bitumen, which is very viscous, coating anything with which it comes in contact, has proven to be a significant hazard to birds making use of the pond (Smith et al. 1975). Once birds have contacted the bitumen their feathers become fouled, making it impossible for them to leave the pond area. With

FIGURE 1. Location of the study area (Suncor Inc. Lease 86) in northeastern Alberta, and the position of observation sites (Appendix II) within the study area. The point from which the morning tailings pond observations were made is shown within Site 5. Various stipplings denote areas of numbered sites (Numbers 3 to 17).


Syncrude Canada Lease
Syncrude Canada Lease
Athabasca River
17
14
15A
16
15
13
11
10
12
9
8
7
6
Observation Point
Pond 1A
Pumphouse
3
4
Pond 1
5
N
Dyke Areas
800 meters
Athabasca River
Lake Athabasca
River
Study Area
Fort McMurray
Athabasca
N
Study Area (Suncor Inc. Lease 86)
0 50 100 miles

continued contact, they often become completely mired down in this material, making even an exit onto the shore difficult (Figs. 2 and 3). The loss of the insulating properties of their feathers plus an inability to move to a feeding area, dooms the birds.

Once the problem of bird deaths in tailings ponds was recognized (Trost 1975), both Suncor and Syncrude initiated investigations to assess the kill rate at these ponds and to design and test devices that would deter birds from entering these waters (Smith et al. 1975, Dyke et al. 1976, Boag et al. 1975 and 1977, Gulley 1977 and 1978, Boag and Lewin 1980).

The importance of assessing the severity of the bird kill problem and in designing a system to deter potential avian users of the pond was reinforced by the fact that the Fort McMurray area is on a major flyway for western arctic waterfowl and immediately south of an important waterfowl staging area, the Peace-Athabasca delta (Bellrose 1976, Hennan 1972). Another consideration involved the fact that northward migration follows the 1.7° C isotherm (Lincoln 1950). Thus, the possibility existed that early migrants moving into the area might find open water available only in the warm tailings ponds and be attracted into them in large numbers.

Boag et al. (1975) determined that members of the subfamily Aythinae, in particular the ring-necked duck (Aythya collaris) and the lesser scaup (Aythya affinis) were the waterfowl species most commonly recovered from the Suncor tailings pond. Also, in conducting investigations on devices to deter waterfowl from landing on natural ponds, they found that a floating human effigy was the only effective device of the 3 tested and that ducks of the

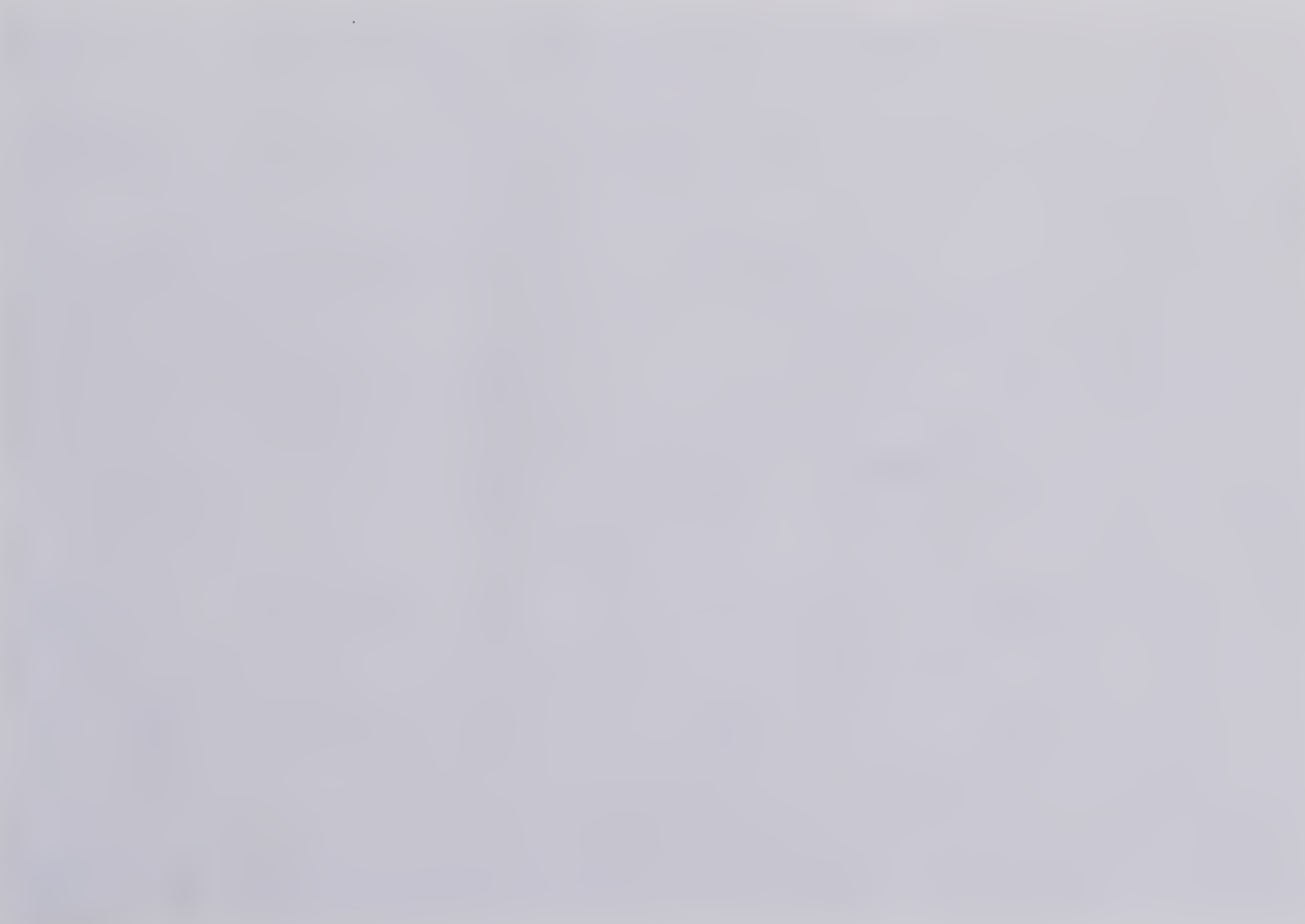


FIGURE 2. Moribund bird on the shoreline of Pond 1 (Site 5 - Fig. 1).

FIGURE 3. Dead bird on the shoreline of Pond 1 (Site 5 - Fig. 1).

genus *Aythya* were affected most by this device (Boag and Lewin 1980). They recommended that floating human effigies be placed on the Suncor tailings pond.

The results of testing of the effigies on a tailings pond during 1976 led Boag et al. (1977) to suggest that the use of the effigies be continued and that a means of lighting the deterrents at night be developed as they believed that most birds, entering the pond while the deterrents were in place, did so during darkness.

These recommendations prompted the study which I undertook from 1977 through 1979 on lands leased by Suncor. The main objective of my study was to develop a means of lighting the deterrents at night and to assess the effectiveness of this new system in diminishing the kill rate in the pond. Because Boag and Lewin (1980) indicated that migrating waterfowl may be more vulnerable to bitumen fouling in these tailings ponds during spring migration than autumn migration, an additional aspect of this study was to examine the relationships among waterfowl abundance in the area, spring weather conditions, and waterfowl losses in a large tailings pond during this period. Additionally, I looked for relationships between waterfowl losses during the summer and autumn seasons and meteorological parameters.

II. STUDY AREA

The study area containing the Suncor Inc. oil sands extraction plant and effluent ponds is located 40 Km north of the town of Fort McMurray (56°44'N,111°35'W) in northeastern Alberta. This area is bounded on the south and east by as yet unexploited land, and to the north and west by the Syncrude Canada Ltd. development (Fig. 1).

The study area lies within the boreal forest but has been severely altered from its native state by the exploitation of the tarsand deposits. Prior to development, 8 major vegetation types were described for the area (Appendix I). They included: 1) fen (sedge and willow or dwarf birch), 2) balsam poplar-willow-alder scrub, 3) white spruce-balsam poplar forest, 4) white spruce-aspen forest, 5) aspen forest, 6) black spruce forest, 7) black spruce-tamarack forest bog complex, and 8) jack pine forest. Most of these original cover types are now restricted to small remnants as 70% of the 2225 ha lease has been cleared for development. Revegetation efforts are underway on sites where changes resulting from industrial development have been completed. The major habitat developed through revegetation is a mixed grass and shrub type with agronomic grasses as the dominant species. Various species of trees have been planted in these areas.

There were 4 natural ponds on the Suncor lease prior to development. Twelve ponds were present during this study including 3 of the original natural ponds, 2 unpolluted man-made ponds, 3 sewage lagoons, 3 bitumen-contaminated tailings ponds and 1 oil-contaminated pond.

Two of the tailings ponds were studied (Fig. 1). The larger of the 2, Pond 1 (Fig. 4), was surrounded by dykes composed of sand with a clay core or overburden (a term denoting muskeg, glacial till and lean tarsand which usually overlies the commercial tarsand of the area (Intercontinental Engineering 1973)). The smaller, Pond 1A, was surrounded by overburden dykes. The inner faces of all dykes were virtually void of living vegetation. The area of surface water on Pond 1 was 186 ha and on Pond 1A, 56 ha. Tailings flowed into Pond 1 continuously except when the extraction plant was shut down (1977: April 19-May 7; 1979: May 21-June 8, August 17-21 and 25-28, September 2-4). Pond 1A received tailings only during the period between October 1977 and March 1978.

Thirteen other sites, including both aquatic and terrestrial areas, were surveyed during the study (Fig. 1). Appendix II details all sites surveyed and describes any physical changes or disturbances that occurred at these sites during the course of the study. Changes included total elimination of a site, vegetation addition or removal, and creation or elimination of an adjacent waste (kitchen garbage, paper, wood, plastic and some metal) disposal area. Disturbances involved varied intensities of human and equipment activity on or within the vicinity of the site.

FIGURE 4. Pond 1 (Site 5 - Fig. 1) showing pipeline and sand dyke in foreground, sand dyke in background, overburden dyke to the right, and the pond surface with the pumphouse floating on the righthand side. Photo was taken from the position at which morning surveys were conducted.

III. METHODS

The efficacy of a human effigy deterrent system was studied during the open seasons of 1977 and 1978. The effect of the addition of artificial lighting of the system at night was studied in 1979. All studies involving effigies were done in Pond 1 (Fig. 1), and ran from April through October of each year.

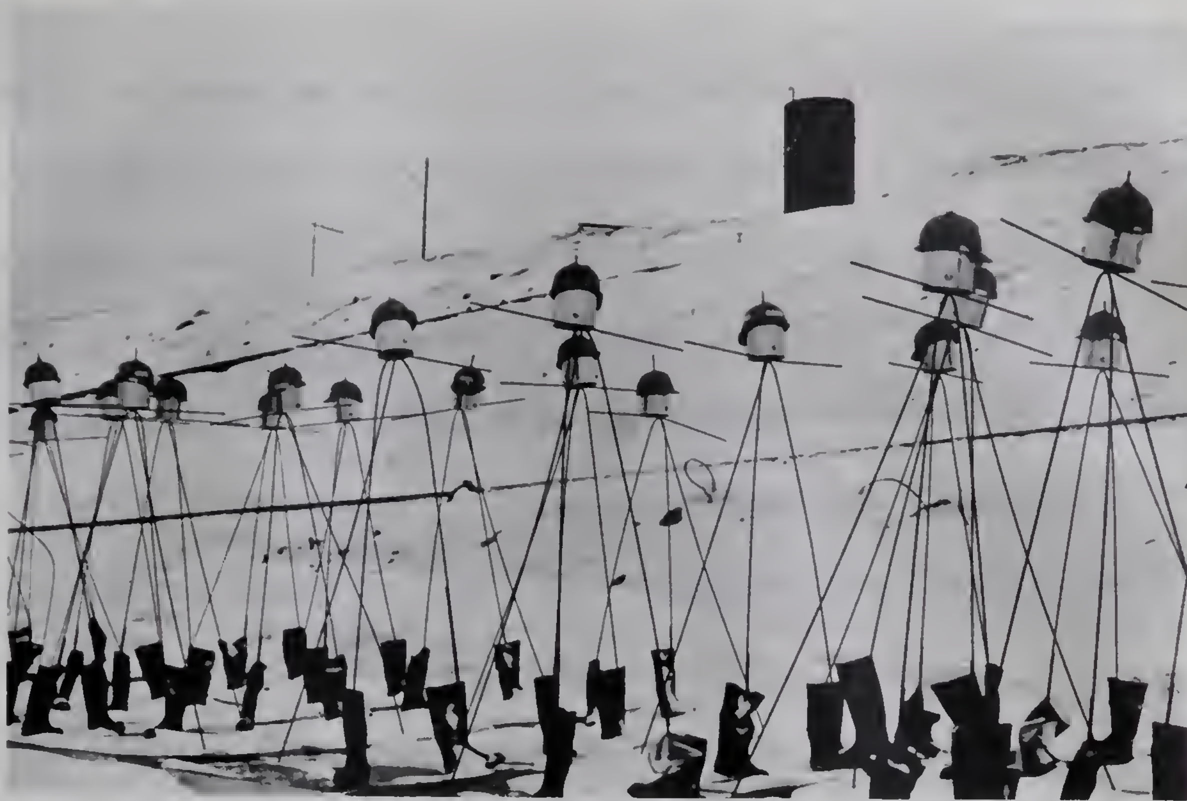
The effigies were clothed men, shaped from metal rods welded to a float platform (Fig. 5). Clothes were fluorescent red-orange polypropylene coveralls (Fig. 6). Thirty effigies were anchored each spring at regular intervals over the pond surface (1977 - May 16, 1978 - April 1, 1979 - April 23). Destruction of some effigies (1977 - 6, 1978 - 9, 1979 - 15), either through breakage of the framework or severance of anchor lines, occurred during the summer of each year. Effigies from the central area of the pond were most often destroyed as they were more exposed to the wind. Replacement effigies were deployed to maintain numbers at a minimum of 24 prior to the autumn migration (relative density: 1 per 7.75 ha).

Results obtained by Boag and Lewin (1980) in their 1975-1976 study suggested that most birds entered the ponds at night, and some means of making the deterrents more visible at night might increase their effectiveness. Additional support for this idea was found in a review of waterbird deterrent and dispersal systems for oil spills (Koski and Richardson 1976). They report that birds, especially waterfowl, are deterred from some areas by searchlights.

The selection of a lighting system was based on a number of

FIGURE 5. Framework of the effigies which were placed on Pond 1 (Site 5 - Fig. 1).

FIGURE 6. Clothed effigies which were placed on Pond 1 (Site 5 - Fig. 1).



considerations. While individual lighting systems mounted on each effigy would provide a more effective means of lighting each deterrent, the problems with deploying and maintaining such a system (damage to parts of the apparatus through bitumen fouling, loss of power through drainage of batteries, loss of expensive equipment if any effigies were destroyed, and the difficulties that weather conditions might have on regular on-pond maintenance of the system) were deemed to be greater than the potential benefits. Thus I chose to light the effigies from a shore-based apparatus, a searchlight.

The light system selected was a Crouse-Hinds, 61 cm, rotating, single-drum beacon (Supplier - Henry Electric Ltd., Edmonton). The light was a 500 watt, 120 V bulb producing 800,000 beam candlepower. The beacon, rotating counterclockwise 12 times per minute, illuminated each effigy briefly every 5 seconds. Such a system required Canada Ministry of Transport approval.

The light was mounted on the pumphouse which floated on the surface of Pond 1 (Fig. 7). In this way, the problem of fluctuating water levels was overcome as the pumphouse floated at a constant level relative to the effigies.

Opting for a large searchlight also presented some problems including the construction of support and protective structures for the beacon. In order to restrict the beam of light to the pond surface, we built a number of guards around it (Fig. 8).

While the original plans called for installation of the light during 1977 with commencement of its operations in the spring of 1978, a number of problems delayed the installation until well into

FIGURE 7. The rotating beacon on the pumphouse at Pond 1 (Site 5 - Fig. 1).

FIGURE 8. The guards which were placed around the rotating beacon at Pond 1 (Site 5 - Fig. 1). Sheet metal guards were used above and behind the beacon, while red-orange plexiglass guards were used in front of the beacon.

1978. As I felt that a full season's use was needed to test adequately the effectiveness of the light system in increasing the deterring effect of the effigies, I decided to extend the study another year. I therefore used 1977 and 1978 as years with the effigies only and 1979 as a test year with the effigy-light system.

Evaluation of the effectiveness of the effigies, following the approach of Boag and Lewin (1980), was based on the premise that the presence of effigies would discourage the entry of waterfowl into the pond and thereby reduce the numbers of birds becoming fouled in it. I postulated that lighting the effigies at night would enhance their overall effectiveness. To make the evaluations, the number of birds exposed to and entrapped in the pond had to be determined for each year.

The number of birds entering tailings ponds 1 and 1A (Sites 5 and 4 - Fig. 1) were determined through regular shoreline surveys during which dead or moribund birds were collected. The species, whenever possible, and state of decay for each bird were recorded. Time of death for each bird was determined from its state of decay using the guidelines developed by Boag et al. (1977)(Appendix III).

Avian presence around the pond was gauged by recording the number and species of all birds seen or heard, on, above or around the pond during a 1-hour survey. These surveys, which under normal circumstances commenced 45 minutes before sunrise, were conducted from a vantage point on the north-west dyke of Pond 1 (Figs. 1 and 4). The timing of these surveys was such that they overlapped, as much as possible, the daily peak period of migratory activity as reported by Richardson and Gunn (1971).

Surveys conducted at 14 sites other than Pond 1 (Site 5 - Fig. 1), provided additional indices of avian abundance. These sites included natural and man-made ponds, natural and disturbed land areas, and a stretch of the Athabasca River. Physical changes occurred at all sites over the 3 years of the study (Appendix II). To lessen the impact of these changes on the estimation of waterfowl abundance, only 5 sites (Nos. 5, 6, 12, 13, and 16 - hereinafter referred to as the major sites - Fig. 1) were used for a detailed analysis of waterfowl numbers. These sites were the ones that underwent changes least likely to influence the levels of waterfowl use (Appendix II), and they accounted for between 84.9 and 94.6% of each springs' waterfowl sightings (Table 1).

Surveys were conducted from a vehicle or by foot. Observations were aided by using binoculars or a spotting scope.

Boag and Lewin (1980) used shorebirds in their analysis of effectiveness of the deterrents. For this study, I chose not to include them because: 1) they did not exhibit any reaction to the presence of the effigies or the lighting system any time they were observed in the tailings pond area; 2) the shorebird kill appeared to be directly related to the relative areas of 'beach' present around the pond (during 1979, when the pond level dropped 0.63 m in the month of August and left much more 'beach' area exposed, increased numbers of shorebirds were recovered from the pond (Appendix IV); and 3) the total number of shorebirds recovered from the pond made up such a small percentage of the total birds recovered (1977 - 0.04%, 1978 - 0.03%, 1979 - 0.08%)(Appendix IV).

TABLE 1 - Total numbers of waterfowl per observation period and the percentage of total sightings (in brackets) for each of the periods April-May, June-July, and August-October, 1977 - 1979, from 5 major sites (Nos. 5, 6, 12, 13, and 16 - Fig. 1).

Site	1977			1978			1979		
Number	Apr-May	June-July	Aug-Oct	Apr-May	June-July	Aug-Oct	Apr-May	June-July	Aug-Oct
5	4657(30)	1371(19)	1183(15)	1185(15)	1517(25)	525(10)	1731(12)	628(5)	29(.4)
6	2962(19)	479(7)	2211(28)	4397(55)	397(7)	635(12)	7686(54)	441(4)	249(3)
12	260(2)	658(9)	1206(15)	76(1)	575(10)	1353(25)	20(.1)	287(2)	1734(21)
13	551(4)	1658(23)	1310(17)	545(7)	1245(21)	1548(29)	467(3)	1182(10)	1457(18)
16	4595(30)	1985(27)	1263(16)	1316(16)	1456(24)	647(12)	3661(26)	9008(77)	4494(55)
Major Site Total	13025(82)	6151(84)	7173(91)	7519(93)	5190(86)	4708(88)	13565(95)	11546(98)	7963(97)
All Others[a]	2781(18)	1180(16)	703(9)	538(7)	823(14)	675(12)	784(5)	224(2)	229(3)
Total	15806	7331	7876	8057	6013	5383	14349	11770	8192
Percent of year	51	24	25	41	31	28	42	34	24

[a]includes sightings from the other 10 sites (Fig. 1)

Therefore in evaluating the effectiveness of the lit and unlit effigies, I confined my analyses to comparative numbers of loons, grebes, geese, swans, ducks, and coots. Consequently, the use of the term waterfowl in this study, denotes members of the following families or subfamilies: Gaviidae, Podicipedidae, Cygninae, Anserinae, Anatinae, Aythyinae, Oxyurinae and Merginae. In addition, the American coot (*Fulica americana*), from the family Rallidae, was included in the waterfowl category.

Since Boag and Lewin (1980) suggested that waterfowl may be more vulnerable to bitumen fouling during spring migration, I have analyzed data for April-May, June-July, and August-October in each of the 3 years.

Data were compared by using the Kruskal-Wallis one-way analysis of variance or by chi-square analysis. Differences were considered significant if $P \leq 0.05$.

IV. RESULTS AND DISCUSSION

The numbers of waterfowl recorded at the 5 major sites during the spring, summer, and autumn seasons of 1977-1979 (Tables 1, 2, and 3) show 4 important patterns: some sites were used more than others both within and among years, species composition of waterfowl recorded differed among years, total numbers recorded changed with the seasons, and total numbers changed with the year.

The number of waterfowl recorded at each site seemed to reflect the physical and biological properties of the site. Two of the major sites surveyed (Sites 5 and 6 - Fig. 1), seemed to attract waterfowl, particularly in the spring. They accounted for between 48 and 69% (Table 1) of all waterfowl sighted during April and May of each year. Although Site 5 does not provide any areas for waterfowl to land safely, feed, or nest (because birds become fouled in this pond), it is a relatively large body of water and is located adjacent to the river which may be a visual migratory cue for passing waterfowl. Many of the waterfowl counted over Site 5, particularly during the spring, appeared to be birds following the river on their northward migration and continuing to fly in a straight line rather than following the bend in the river south of Site 5 (Fig. 1). Site 6 provides excellent landing and feeding areas but only limited nesting sites. The numbers of waterfowl recorded at Site 6 during the spring depended largely on when spring breakup occurred on the Athabasca River. A stretch of the river opposite and to the north of the study area remains open throughout the year

TABLE 2 - Mean numbers of 6 species of waterfowl recorded per observation at the major and all sites (Fig. 1) during the periods April-May, June-July, and August-October, 1977 - 1979.

Species/Period[a]	Site[b]	1977				1978				1979			
		1	2	3	4	1	2	3	4	1	2	3	4
Mallard	M	8.3	9.5	2.1	6.3	14.6	8.6	4.6	9.4	24.9	15.7	7.3	15.8
	A	4.0	4.1	1.2	2.9	5.9	3.9	2.6	4.2	9.6	6.5	2.9	6.3
Pintail	M	19.4	0.6	0.7	6.5	3.0	0.4	1.4	1.6	5.1	6.2	2.5	4.4
	A	7.4	0.2	0.3	2.5	1.2	0.2	0.6	0.6	2.1	2.4	1.0	1.7
Green-winged Teal	M	6.4	4.3	4.7	5.1	3.7	1.8	4.6	3.4	5.5	19.0	8.8	10.2
	A	3.0	2.0	2.2	2.4	1.6	0.9	1.9	1.5	2.1	7.3	3.4	3.9
Ring-necked Duck	M	0.6	1.1	<0.1	0.5	0.7	1.0	0.2	0.6	2.1	4.6	1.1	2.3
	A	0.8	0.4	<0.1	0.4	0.3	0.4	0.1	0.3	0.8	1.8	0.4	0.9
Lesser Scaup	M	2.2	0.3	0.2	0.9	2.3	0.3	<0.1	0.9	4.7	2.0	0.1	2.3
	A	1.3	0.4	0.1	0.6	0.9	0.2	<0.1	0.4	1.7	0.8	0.1	0.9
Common Goldeneye	M	2.5	1.1	0.5	1.3	4.2	3.5	1.1	3.0	5.6	3.8	2.0	3.8
	A	1.1	0.4	0.2	0.5	1.7	1.6	0.5	1.3	2.3	1.5	0.8	1.5

a Observations per period

	1977		1978		1979	
	Major	All	Major	All	Major	All
1. Apr-May	183	488	191	509	207	566
2. June - July	175	461	178	472	143	374
3. Aug-Oct	225	602	180	477	221	585
4. Apr-Oct	583	1551	549	1458	571	1525

b Site : M = Major sites (Nos. 5, 6, 12, 13, 16 - Fig.1) ; A = All sites (Fig.1)

TABLE 3 - Mean numbers of waterfowl recorded per observation period at the 5 major and all sites (Fig. 1) during the periods April-May, June-July, August-October, and April-October, 1977 - 1979. Maximum number, recorded during a single observation period, of any species within each category is given (minimum number = 0).

Waterfowl Category	Site[a]	1977 1A[c]	1977 1B[d]	1977 2A	1977 2B	1977 3A	1977 3B	1977 4A	1978 1A	1978 1B	1978 2A	1978 2B	1978 3A	1978 3B	1978 4A	1979 1A	1979 1B	1979 2A	1979 2B	1979 3A	1979 3B	1979 4A
Geese/	M	6.3		0.1		10.2		5.9	0.8		0.1		3.8		1.5	2.7		0.3		1.2		1.5
Swan			476		9		1287			55		36		215			252		31		110	
	A	3.2		0.1		3.9		2.5	0.3		0.1		1.3		0.7	1.0		0.1		0.4		0.6
Dabblers[e]	M	44.7		21.6		14.2		26.0	27.0		20.1		17.7		21.0	42.5		59.3		26.1		40.3
			456		257		63			670		131		107			879		182		108	
	A	19.4		9.2		6.3		11.3	11.4		8.9		6.4		9.3	16.6		23.2		10.2		15.7
Divers[f]	M	7.3		5.6		1.3		4.5	9.6		6.8		1.7		6.1	17.5		15.2		5.7		12.4
			53		39		16			84		26		11			66		34		23	
	A	4.0		2.6		0.6		2.2	3.8		3.0		0.8		2.5	6.7		5.9		2.3		4.8
Unident.	M	8.6		4.1		3.3		5.2	0.8		1.8		1.7		1.4	1.1		1.4		0.2		0.8
Duck			457		238		194			85		165		185			106		102		23	
	A	3.2		1.5		1.2		1.9	0.3		0.7		0.7		0.5	0.4		0.5		0.1		0.3
American	M	4.3		3.8		2.9		3.6	1.3		2.2		1.2		1.6	1.8		4.5		4.3		3.5
Coot			74		83		86			21		41		51			30		50		114	
	A	1.7		1.5		1.1		1.4	0.5		0.8		0.4		0.6	0.7		1.7		1.6		1.3
All	M	71.2		35.1		31.9		45.2	39.4		29.2		26.2		31.7	65.5		80.7		36.0		57.9
Waterfowl			2161		514		1449			738		383		429			1362		875		463	
	A	32.4		15.9		13.1		20.0	15.8		12.7		11.3		13.3	25.4		31.5		14.0		22.5

(Periods[b])

[a] M = the major sites - Nos. 5, 6, 12, 13, 16 (Fig. 1); A = all sites in total (Fig. 1).

[b] See footnote a, Table 2 for explanation of periods and the numbers of observations at the major and all sites during those periods.

[c] Mean numbers of waterfowl.

[d] Highest number of one species within each category recorded during the period. Number for period 4 is not given as it is equal to the highest value given in periods 1, 2, or 3.

[e] Dabblers include members of the subfamily Anatinae.

[f] Divers include members of the families Gaviidae and Podicipedidae, and the subfamilies Aythyinae, Oxyurinae, amd Merginae.

as a result of warmed waters returned to the river from the process plant. This area and Site 7 (Fig. 1) comprise the only open and unpolluted water available to waterfowl during the early spring. When ice remains on the river late into the spring (as it did in 1979), waterfowl congregate on open reaches, resulting in the higher counts recorded at Site 6 in that year (Table 1).

The other major sites (Fig. 1) were more attractive to waterfowl during the summer or autumn (Table 1). Of these other sites, Site 12 was the smallest (Appendix II) but provided an excellent feeding area, especially during the summer and autumn. Site 13, the next smallest (Appendix II), has a limited number of nesting areas and is a good waterfowl landing and feeding area. Site 16 is the optimal waterfowl area on the study area as it provides excellent landing, nesting, and feeding areas for all types of waterfowl in the area. Numbers recorded at this site during the autumn of 1977 and 1978 (Table 1) may not be representative of actual numbers present, as the number of surveys conducted during those years was small because of site access problems (1977:19, 1978:7, 1979:36).

Numbers of waterfowl recorded at Sites 5 and 6 during the autumn of 1979 were much lower than in either of the previous 2 years (Table 1). These figures suggest a change in the autumn migratory pattern over the study area in 1979. Since these low counts are supported by similar findings on the Syncrude Canada Ltd. lease (Keith Yonge - personal communication 1979), I believe they reflect an actual change in numbers and not a sampling bias.

In summary, the differences in the levels of use at each site within years, depends on the nature of the site, its location

relative to flight lines, and the ways in which waterfowl use it. Differences between years reflect the levels of waterfowl numbers in the area, including changes in numbers because of the effects of weather conditions.

Numbers of 6 waterfowl species have been examined to help illustrate changes in species composition recorded within and among years (Table 2). During 1977, the highest numbers for 5 of the species were recorded during the spring. Only the peak counts of mallards (Anas platyrhynchos) and ring-necked duck were recorded during the summer. I believe the counts of this year reflect conditions for years with early springs as the result of warm temperatures. Higher numbers of pintails (Anas acuta) and green-winged teal (Anas crecca) were counted during the spring of 1977 (Table 2). This may reflect a significant northward displacement of birds from more southerly breeding grounds (Calverly and Boag 1977) as the result of widespread drought conditions in that year (Environment Canada 1977). Derksen and Eldridge (1980) reported exceptionally large numbers of pintails in Alaska during 1977, these birds were assumed to have been displaced north by drought conditions on the plains.

Counts of ring-necked duck were highest during the summers of all 3 years (Table 2). This reflects the presence of a breeding population on the study area and the fact that this species was seldom recorded during spring or autumn migrations.

In 1978, the highest counts were again recorded during the spring for 4 of the species. Peak numbers of green-winged teal were recorded during the autumn but they and the highest numbers recorded for most species during 1978 were recorded during migratory periods.

The spring counts for mallards during 1978 and 1979 were higher than in 1977 partially because of conditions relating to breakup of ice on the Athabasca River. During years in which ice breakup is late (as in 1978 and 1979), high numbers of mallards are recorded among ice flows on the river immediately following breakup. Counts of mallards at Site 6 (Fig. 1) for the springs of 1978 and 1979 accounted for 30 and 41% of the respective years total counts of mallards.

Highest counts during 1979 were recorded during the spring for 3 of the species and during summer for the others. The species with high spring counts are again an indication of the presence of greater numbers during migratory periods, while those with high summer counts reflect their increased presence as breeding species on the study area. The significantly higher counts of mallards during the summer of 1979 also indicates that a greater number of this species remained on the study area to breed.

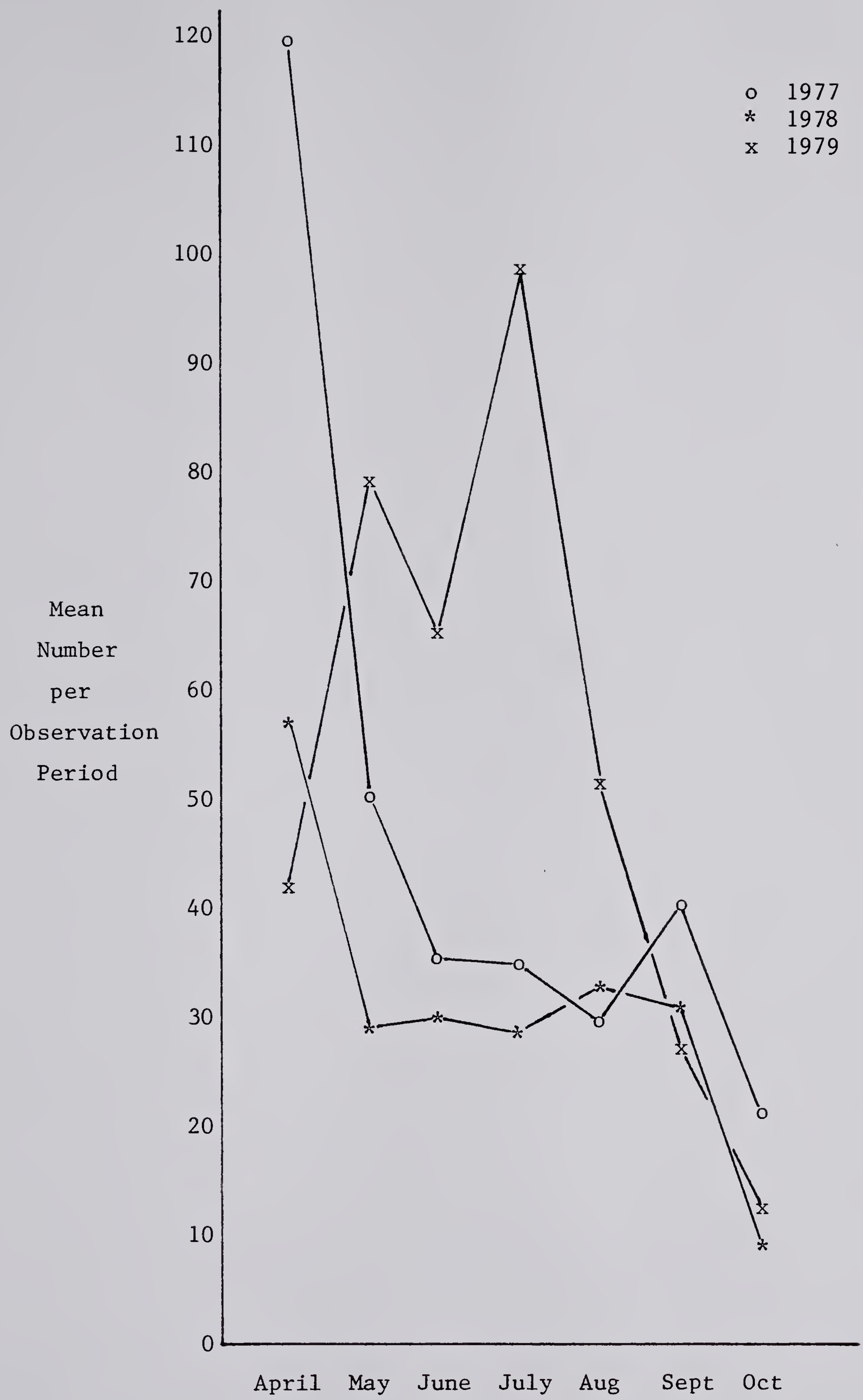
Data on the range of numbers recorded for individual species within the different categories of waterfowl are given in Table 3. They show that the highest number (1287) recorded at a single observation were of snow geese (<u>Chen caerulescens</u>) at Site 6 (Fig. 1) on September 15, 1977. Highest numbers of individual species of dabblers or divers recorded at a single observation were made during the spring of each year with the numbers of dabblers much higher than those of divers. Highest numbers of American coot were recorded during the autumn of each year, a time when the young of the year also were counted.

In summary, the species composition of the waterfowl counted

changed both within and among years as a result of a combination of factors. Of primary importance is the influence of weather conditions, both in the region of the study area and in other regions, on the migratory movements of waterfowl through the area. Other factors include changes in numbers of certain species remaining on the study area to breed, possibly because of changing characteristics of the local water bodies or because of the weather conditions during spring migration. Of some importance is the element of chance during censuses, in that by being at the right site at the right time and on the right day, a large number of a particular species may be recorded that otherwise would not have been seen, for example, the snow geese on September 15, 1977.

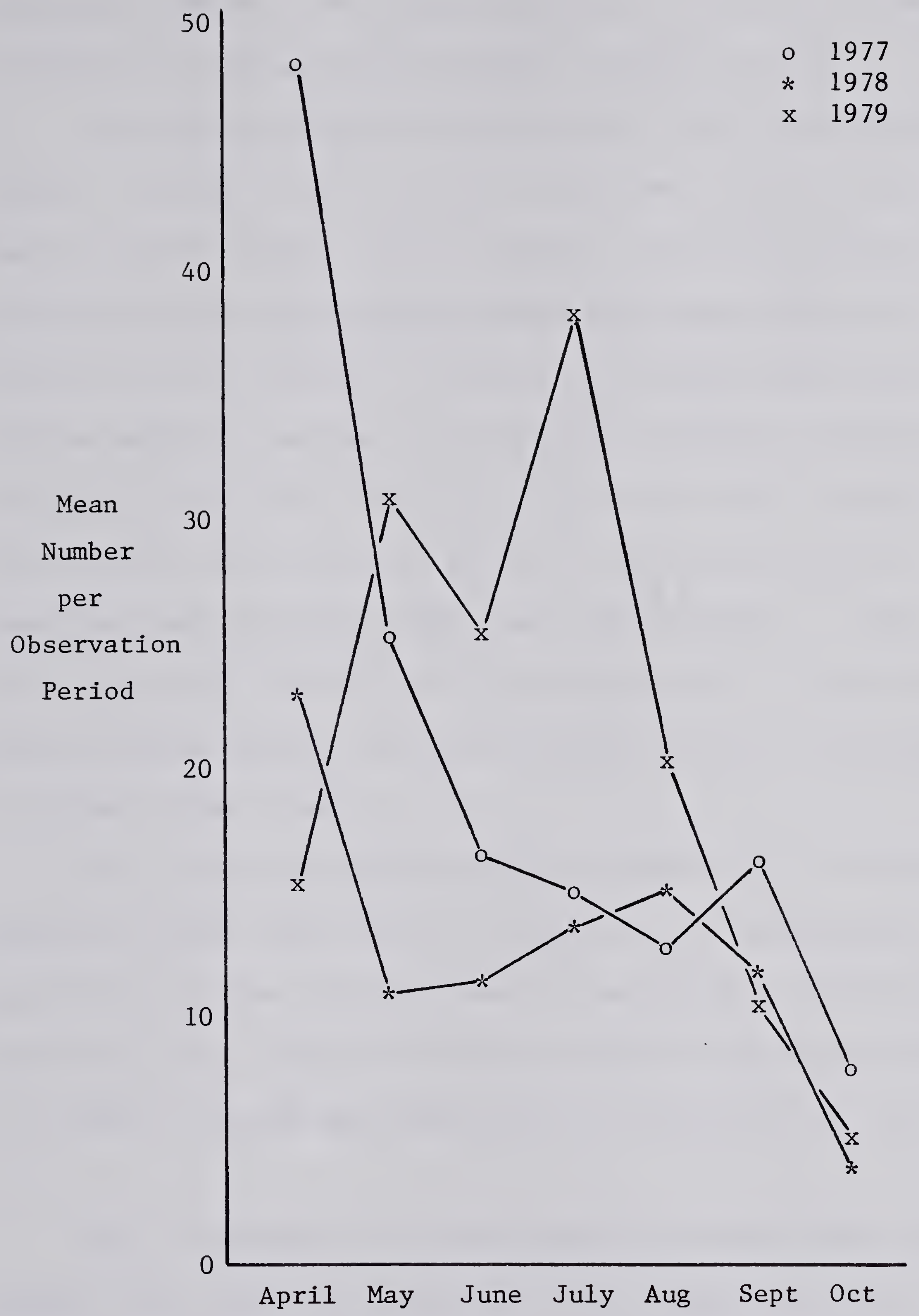
Like Boag and Lewin (1980), I found that the number of waterfowl recorded on the study area differed among months (Table 1, Figs. 9 and 10, Appendix VII). Boag and Lewin's data (1980 : Table 6) indicate an increasing number of waterfowl until a peak was reached in September, followed by a rapid decline. My data show that in both 1977 and 1978 the highest mean numbers of waterfowl per observation period were recorded during the spring (April-May : Table 3), while in 1979, this peak came during the summer (June-July : Table 3). The difference in 1979, from the previous 2 years, reflected the large numbers of waterfowl recorded at Site 16 (Fig. 1) during the summer (Table 1). These large numbers were attributable to a greater population of breeding birds which stayed to nest at this site probably because of climatic influences during the spring of 1979 (see next section). The difference between Boag and Lewin's (1980) data and mine may also be attributable, in part, to procedural

FIGURE 9. Mean number of waterfowl recorded at the major sites on the study area (Nos. 5, 6, 12, 13, and 16 - Fig. 1) during April - October, 1977 - 1979. (See Table 1 for totals and Appendix VII for data.)



120
110
100
90
80
70
60
50
40
30
20
10
0
Mean
Number
per
Observation
Period
o 1977
* 1978
x 1979
April
May
June
July
Aug
Sept
Oct

FIGURE 10. Mean number of waterfowl recorded at all sites on the study area (Fig. 1) during April - October, 1977 - 1979. (See Table 1 for totals and Appendix VII for data.)


o 1977
* 1978
x 1979
Mean Number per Observation Period
50
40
30
20
10
0
April
May
June
July
Aug
Sept
Oct

differences among observers and to their familiarity with the sites, the timing, number of, and site at which observations were conducted. They may also reflect differences in numbers of waterfowl in the area at the specific time when censuses were done.

The number of waterfowl recorded each year varied considerably (Table 1: 31,013 in 1977, 19,543 in 1978, and 34,311 in 1979). Total numbers counted during 1979 are similar to 1977 but apparently for different reasons. Cool spring weather conditions (Appendix V) resulted in slow melting of ice-cover on northern lakes and rivers forcing waterfowl passing into this area to seek any available open water they could find. Ponds in the study area opened earlier than those farther north and, as a result, an increased number of waterfowl remained in the study area to breed (Table 1). Thus, in 1977, conditions farther south were responsible for higher spring counts whereas in 1979, conditions farther north were responsible for higher summer counts.

Use of Boag and Lewin's (1980) assumption that the number of waterfowl liable to be fouled by bitumen in the tailings pond could be predicted if the relative numbers of waterfowl in the area were known each year, enabled me to make a number of predictions (Table 4) on both a seasonal and yearly basis by using the data from Table 3.

These predictions, like those made by Boag and Lewin (1980), assumed that conditions on or about the tailings pond (Site 5 - Fig. 1) remained unchanged from one year to the next. This assumption was valid for 1977 to 1978 but not for 1978 to 1979. The change in the

TABLE 4 - Number of birds counted at the major sites (Fig. 1) in 1977, 1978, and 1979 and a prediction of the numbers (index) of oiled birds based on 1977 as 1.00.

	1977	1978	1979
Actual numbers counted (Apr-May)[a]	71.2	39.4	65.5
Index of predicted number fouled	1.00	0.55	0.92
Actual numbers counted (June-July)[a]	35.1	29.2	80.7
Index of predicted number fouled	1.00	0.83	2.30
Actual number counted (Aug-Oct)[a]	31.9	26.2	36.0
Index of predicted number fouled	1.00	0.82	1.13
Actual numbers counted (Apr-Oct)[a]	45.2	31.7	57.9
Index of predicted number fouled	1.00	0.70	1.28

[a] Mean numbers - based on data in Table 3.

latter case involved the addition of night-lighting of the effigies.

The number of bitumen-fouled waterfowl recovered from Pond 1 is recorded in Table 5. All fouled birds recovered each year had died in that year based on the rates of decay (Appendix III). The extent to which the predictions of Table 4 are supported is presented in Table 6. These predictions for 1978 were not upheld in the spring (22 vs 12 - Table 6), nor the autumn (17 vs 48 - Table 6) but they were in the summer (7 vs 10 - Table 6). In 1979 the spring prediction was not sustained (36 vs 195 - Table 6), but the summer (18 vs 19 - Table 6) and autumn (24 vs 23 - Table 6) predictions were sustained. Based on the full season, predictions of total waterfowl recovered in 1978 (48) were different from actual numbers (70) recovered, as they were in 1979 (87 predicted vs 237 recovered).

Therefore, because the number of waterfowl recovered during the spring of 1978 and 1979 and the autumn of 1978 were different from those predicted, I examined other factors which may have been different between years and thereby influenced the rate of bird fouling in the tailings pond.

In examining other possible factors which may have influenced numbers of waterfowl being fouled in the tailings ponds, I started with the deterrent systems used on the pond. As Boag and Lewin (1980) pointed out, placement of the effigies on the tailings pond decreased the levels of bird fouling in it. Therefore, I assumed that the effigies on the pond during my study had the same effect, and, if they were present each year, this effect should have been equal for all years. There were however, 2 variations in the deterrent system during my study. The first involved the dates on which the new effigies

TABLE 5 - Numbers of waterfowl found dead or moribund in or on the shores of Pond 1 (Site 5 - Fig. 1) during 1977 - 1979. (Shoreline searches conducted at least once per week.)

Category	Numbers found during											
	Apr-May			June-July			Aug-Oct			Apr-Oct		
	1977	1978	1979	1977	1978	1979	1977	1978	1979	1977	1978	1979
Grebes (Podicepedidae)	0	1	2	0	0	0	0	0	0	0	1	2
Geese (Anserinae)	0	0	1	0	0	0	0	0	0	0	0	1
Dabbling Ducks (Anatinae)	5	4	83	3	5	14	5	34	16	13	43	113
Diving Ducks (Aythinae)	7	3	78	1	1	4	9	3	3	17	7	85
Mergansers (Merginae)	0	0	3	0	0	0	0	0	0	0	0	3
Unidentified Ducks	1	0	20	1	1	0	2	2	0	4	3	20
Coots (Rallidae)	26	4	8	3	3	1	5	9	4	34	16	13
Total Waterfowl	39	12	195	8	10	19	21	48	23	68	70	237
% of Year	57	17	82	12	14	8	31	69	10	100	100	100

TABLE 6 - Predicted and actual numbers of waterfowl recovered from Pond 1 (Site 5 - Fig. 1).

Season	1977		1978		1979	
	Actual	Predicted[a]	Actual	Predicted	Actual	Predicted
Apr-May	39	--	12	22	195	36
June-July	8	--	10	7	19	18
Aug-Oct	21	--	48	17	23	24
Total	68	--	70	48	237	87

[a]Based on Table 4.

were placed on the pond. (New effigies must be placed on the pond each year as those of the previous year are destroyed during the winter.) These dates varied from one year to the next (1977 - May 16, 1978 - April 1, 1979 - April 23). Based simply on the variation in placement date, I would expect that, if numbers of waterfowl over the pond were equal for each year and if the effigies were in fact effective at deterring waterfowl, the spring kill would be lowest in 1978, highest in 1977 and somewhere between these levels in 1979. Fluctuations in waterfowl numbers over the pond from one year to the next would influence these expectations. Data from Table 3 shows 1977 to have the highest spring mean waterfowl numbers with 1979 the second highest and 1978 the lowest. Combining the mean numbers of waterfowl counted with my expectations of kill based on effigy placement date, I would predict that 1977 would have a fairly high kill, 1978 a low kill, and 1979 a kill somewhere between that of the previous 2 years. Referring to Table 4, it is apparent that the predictions are realized for 1977 and 1978 but not in 1979 when the kill recorded was the highest of the 3 years.

The second variation in the deterrent system was the addition of a lighting apparatus to it. I postulated that by making the effigies more visible at night, their overall effectiveness would be enhanced and , as a result, the bird kill would decrease. As 1979 was the only year in which the light was operating, I would expect the 1979 kill to decrease. This prediction is not supported by the data (Table 4).

Another factor that might influence the rate of bird kill in

the tailings ponds was the condition of the weather during each of the 3 years. Several predictions on the potential effects of weather on the incidence of bird fouling were made: 1) cold spring temperatures, delaying ice-breakup on natural water bodies, would decrease the amount of open water available to waterfowl and result in increased pressure on birds to enter the tailings ponds; 2) increased number of days with measurable precipitation, may have increased the chances of birds entering the tailings ponds, as birds flying under such conditions tend to fly low and may seek shelter in any open and relatively sheltered pond (Richardson 1978).

The study area's mean monthly temperatures, as recorded by Suncor Inc. personnel, for the years 1977 to 1979, and the Fort McMurray 27-yr means, as recorded by the Atmospheric Environment Service, are given in Appendix V. Appendix VI gives the monthly amounts of precipitation and days of recordable precipitation for the study area during 1977 to 1979 and the 27-yr means for Fort McMurray.

Following the same approach to the data on weather as I did for mean numbers of waterfowl and the deterrent systems, and using the temperatures given in Appendix V, I predicted that April-May (spring) conditions were most favorable during 1977 with a spring mean temperature of $10.4^{\circ}C$, favorable during 1978, with a spring mean temperature of $6.4^{\circ}C$, and least favorable during 1979 with a spring mean temperature of $2.8^{\circ}C$. The 27-yr spring mean temperature of $5.1^{\circ}C$ indicates that both 1977 and 1978 were warmer than normal while 1979 was colder.

Consideration of the effects of the mean amounts of precipitation and percentage of days with measurable precipitation is important during each of the spring, summer, and autumn seasons. I have assumed that the lower the amount of precipitation, and, most importantly, the lower the percentage of days with measurable precipitation, the more favorable the conditions for avoiding entry into tailings ponds by passing waterfowl.

From the data presented in Table 7, the following mean amounts of precipitation and days with measurable precipitation can be determined: 1) 1977 - Spring: 4.3 mm during 21% of the days; Summer: 4.0 mm during 39% of the days; and Autumn: 4.7 mm during 26% of the days. 2) 1978 - Spring: 6.6 mm during 21% of the days; Summer: 4.1 mm during 43% of the days; and Autumn: 5.1 mm during 58% of the days. 3) 1979 - Spring: 8.3 mm during 31% of the days; Summer: 8.5 mm during 38% of the days; and Autumn: 4.8 mm during 38% of the days. All of these years may be compared with the 27-yr means from Fort McMurray - Spring: 3.1 mm during 28% of the days; Summer: 5.6 mm during 39% of the days; and Autumn: 4.6 mm during 34% of the days.

Comparisons between each of the 3 study years and the 27-yr means led me to make the following predictions: 1) 1977 - with both amounts of precipitation and number of days of measurable precipitation throughout the year lower than the 27-yr mean, the numbers of waterfowl entering the pond should not be greatly influenced by rainfall. 2) 1978 - with low number of days of measurable precipitation and only slightly higher or lower amounts during the spring and summer, bird entry into the ponds should not be seriously affected during

TABLE 7 - Total days with measurable precipitation and the amounts recorded at Suncor Inc. for 1977, 1978, and 1979, and the 27-yr. mean for Fort McMurray (See Appendix VI).

	1977			1978			1979			27-yr		
Periods[a]	1	2	3	1	2	3	1	2	3	1	2	3
Total days with measurable precipitation	13	24	24	13	26	53	19	23	35	17	24	31
% of period	21	39	26	21	43	58	31	38	38	28	39	34
Total precipitation in mm	55.3	96.2	112.6	86.0	107.3	271.1	157.0	196.1	168.1	53.3	135.2	141.2
Mean precipitation per day of measurable prec.	4.3	4.0	4.7	6.6	4.1	5.1	8.3	8.5	4.8	3.1	5.6	4.6

[a] 1 = Spring (Apr-May) - 61 days; 2 = Summer (June-July) - 61 days; 3 = Autumn (Aug-Oct) - 92 days.

either season. However, the autumn records of amount and number of days of measurable precipitation are both very high and would indicate that rainfall might have a significant effect during that season. 3) 1979 - the number of days of measurable precipitation and especially, the amounts of precipitation were very high all year, leading me to predict that rainfall might have a significant effect on number of waterfowl entering the ponds.

Data from Table 5 supports these predictions with 2 variations, both during 1979. The first involves the spring, a time of very high waterfowl kill which is however more likely to be attributable to cold temperatures rather than increased precipitation. However, the increased precipitation was likely an additive factor in the kill levels. The second variation occurred during the autumn when precipitation levels were only slightly higher than normal. Any increase in precipitation levels would have been compensated for in the kill levels by the much lower numbers of waterfowl sighted in the tailings pond area (Sites 5 and 6 (Fig. 1) - Table 1). These lower numbers suggest that fewer birds would have been susceptible to the effects of the increased precipitation.

A final weather factor which might influence the numbers of waterfowl entering the tailings ponds is the presence of fog banks over or around the ponds (Richardson 1978). Croft et al. (1976) conducted a preliminary investigation into the magnitude of fog occurrence in the Athabasca Oil Sands area. Their findings indicated that fog might be expected more commonly near the oil sand plants than at Fort McMurray, but that predictions of expected days with fog

could not be made using the information at their disposal. While occurrences of fog were noted during this study, detailed records of individual events were not kept with the exception of an incident on May 15, 1979. On this date, Pond 1 (Site 5 - Fig. 1) was ringed by fog with the areas south, east, and north of the pond fog covered. During the morning pond observation period on this day, 569 individual waterfowl were counted over the pond (23.8% of 1979's total waterfowl count at this site). Also, 129 waterfowl were observed landing or as having landed in the pond during the period commencing 30 minutes before sunrise and continuing for 3 hours (54.7% of 1979's waterfowl kill at Pond 1 - Appendix IV).(During this and other poor weather conditions, ducks already in the pond may act as decoys attracting others into the pond.) I could therefore, in this instance, relate the occurrence of a large number of waterfowl over the pond and the presence of fog with a large entry of waterfowl into an effigy-covered tailings pond.

After indentifying those factors which may potentially influence the entry of birds into tailings ponds, and showing that these factors individually help to explain some but not all of the findings of this study, an attempt to integrate the factors was made. As the percentage of kill recorded each year varied among seasons (Table 5), I looked for the factors most important during the individual seasons.

Assuming that the most important factor is the mean numbers of waterfowl recorded on the study area because these numbers reflect the potential levels of use waterfowl might make of the tailings ponds, I first examined the results of my predicted kill levels based on these mean numbers (Tables 4 and 6).

Table 6 shows that the kill was accurately predicted from relative numbers of waterfowl for all seasons of each study year except the springs of 1978 and 1979, and the autumn of 1978.

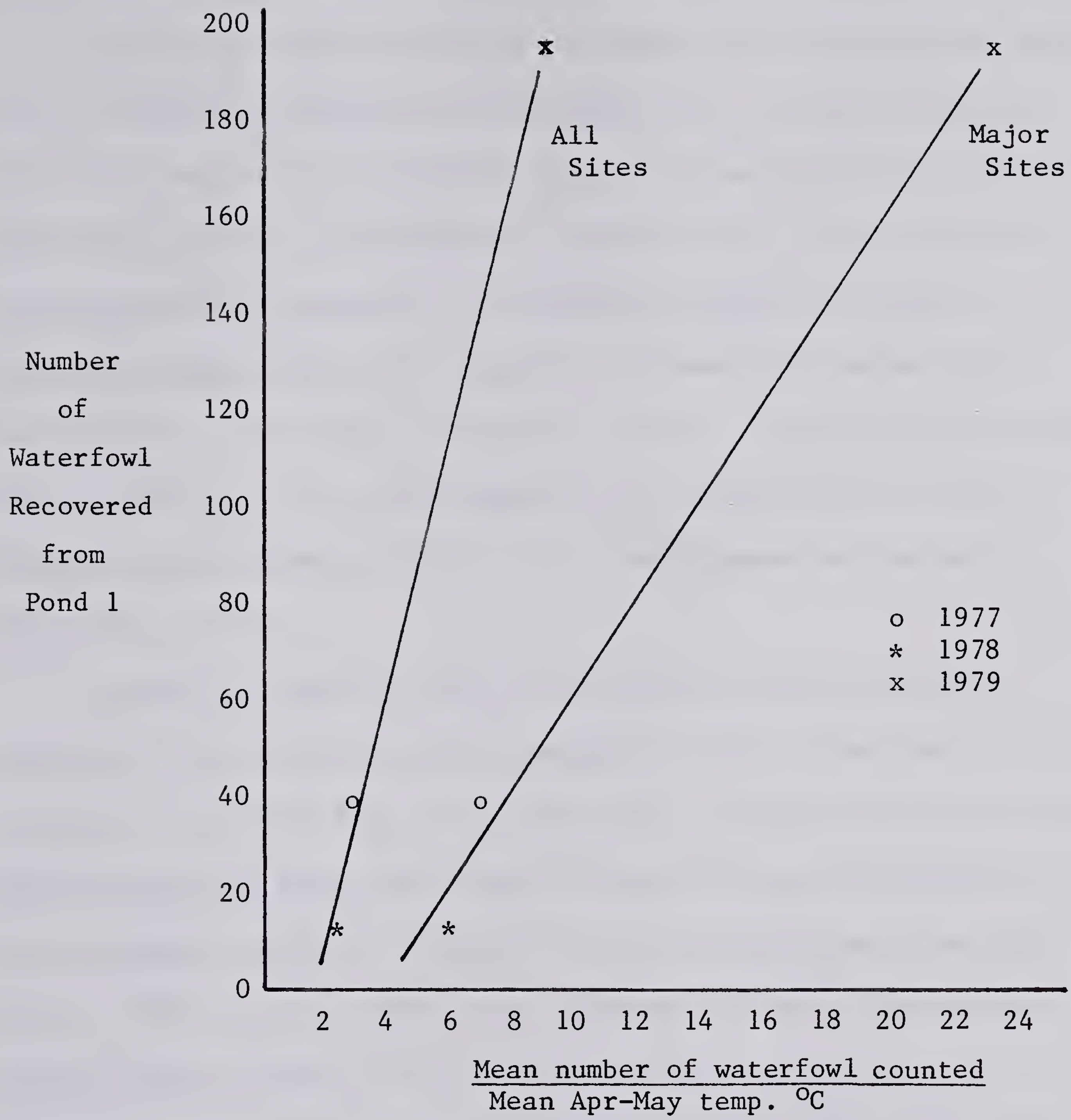
In examining factors relative to events during the spring (April - May), I pointed out that cold spring temperatures may be important. If the mean spring temperatures, the mean numbers of waterfowl, and the recovered kill are examined (Table 8), an important relationship is evident (Fig. 11). Because the temperature is inversely related to kill (ie. the higher the temperature, the lower the kill), I postulated that by dividing the mean number of waterfowl recorded by the mean spring temperature, and relating this value to the recovered kill, that I would be able to develop a means of predicting future kill levels from recorded numbers and temperature. Figure 11 illustrates the results based on the relationship among numbers, temperature, and kill of waterfowl for both the major and all sites (Fig. 1). This relationship suggests that it may be possible to estimate the kill of waterfowl in the tailings pond, based on the mean number of waterfowl counted in the area and the spring temperature recorded for the area.

The displacement of some points from the mean slopes (Fig. 11) may be attributable to the placement dates for effigies, assuming that the earlier the placement of effigies on the pond, the lower the expected recovered kill. The slopes of the lines (Fig. 11) may have been increased by factors other than mean numbers or temperature, for example the presence of fog during the incident on May 15, 1979. However, rather than the fog, the fact that a large number of waterfowl (23.8% of 1979's total waterfowl count at this site) were

TABLE 8 - Mean number of waterfowl sighted (Table 3), mean spring temperature (Appendix V), and recovered waterfowl kill (Table 5) for the months April and May at the major sites (Nos. 5, 6, 12, 13, and 16 - Fig. 1) and all sites (Fig. 1) during the years 1977 - 1979.

	Mean Number Sighted			
Year	Major Sites	All Sites	Temperature	Kill
1977	71.2	32.3	10.4	39
1978	39.4	15.8	6.4	12
1979	65.5	25.4	2.8	195

FIGURE 11. Relationship among the mean number of waterfowl counted at both the major and all sites (Fig. 1), the mean April-May temperature, and the number of waterfowl recovered from Pond 1 (Site 5 - Fig. 1), 1977 - 1979. (Data from Table 8.)



Number
of
Waterfowl
Recovered
from
Pond 1
200
180
160
140
120
100
80
60
40
20
0
2
4
6
8
10
12
14
16
18
20
22
24
All
Sites
Major
Sites
o 1977
* 1978
x 1979
Mean number of waterfowl counted
Mean Apr-May temp. °C

present over the pond at a time when little open water other than tailings ponds was available for their use, may have been the reason for the large influx of birds into the pond. Therefore, the fog may simply have been an additive rather than a causal factor.

Conditions important during the autumn of 1978 which may account for the difference between the recovered kill from that predicted (Table 6), were those associated with days of measurable precipitation and total amounts of precipitation (Table 7). The levels of both of these factors were much higher than normal during the autumn of 1978 (days with measurable precipitation - 71% over 27-yr mean; total precipitation - 92% over 27-yr mean), and if we assume that the birds were responding to the rainy weather in a manner similar to that described by Richardson (1978), this might account for the much higher kill levels.

Questions regarding the effectiveness of the effigies as deterrents may be addressed by examining 2 points. The first of these relates to the fact that, as Boag and Lewin (1980) pointed out, the human effigy was shown to be most effective in deterring members of the genus *Aythya*. Comparison of data for kill of *Aythya* spp. from Boag et al. (1977) and from this study (Appendix IV) shows that members of this genus accounted for the following percentages of total waterfowl kill: 1975 (without deterrents) - 36%, 1976 - 23%, 1977 - 18%, 1978 - 7%, and 1979 - 23%. These data suggest that while there have been significant fluctuations in the levels of kill of *Aythya* spp., the kill has never reached the level that was evident in 1975 prior to the use of deterrents despite recording similar or increased numbers of members of the genus (Table 2).

The second point relates to the date on which deterrents were deployed on the pond surface. The fact that deterrents were placed on the tailings pond later in the springs of 1977 and 1979 seems to have been a factor adding to the kill levels recorded during the springs of both years.

Both of the above points lend support to the contention held by Boag and Lewin (1980) that the effigies were effective devices for deterring waterfowl from entering tailings ponds.

Evaluation of the effectiveness of the light system is handicapped by atypical weather conditions in 1979, especially during the spring. Besides significantly lower spring temperatures (Appendix V), the incidence of waterfowl entry into the tailings pond during daylight conditions was much greater than that recorded during previous years. During 500 hours of observations made at Pond 1 (Site 5 - Fig. 1) between 1976 and 1979, only 15 waterfowl were observed entering the pond (0.03/hour), whereas during the 46 hours of observation in April and May of 1979, 129 waterfowl were observed entering the pond (2.80/hour), albeit all in 3 hours on May 15. The reason for testing a lighted effigy system was the suggestion by Boag and Lewin (1980) that most birds entered the pond in darkness, but, as at least 51% of the recovered kill in 1979 entered the pond during daylight, adequate testing of the light system during the spring was impossible. Looking at 1979's summer and autumn data for waterfowl numbers (Table 3), waterfowl kill (Table 5), and days and amounts of precipitation (Table 7), it can be seen that kill levels are as expected if only waterfowl numbers are examined (Table 6), but lower than expected when the effects of higher

number of days of and amounts of precipitation are incorporated with these numbers. As previously mentioned, the lower kill levels recovered may be attributable to lower numbers of waterfowl present in the pond area (Table 1) during the autumn, however the fact that there were lower kill levels recorded throughout the summer and autumn of 1979 may be attributable to the lighted effigies and may be an indication that the light system was in fact increasing the effectiveness of the effigies.

V. SUMMARY

From an examination of the conditions which may affect the entry of waterfowl into tailings ponds, despite the presence of deterrents, and reference to their importance during the different seasons in a year, an importance rating for each factor in each season was assigned. Table 9 details this rating system. Mean numbers of waterfowl have the most important influence on kill rates throughout the year. This is followed by mean temperatures during spring and the amount of precipitation and number of days of measurable precipitation during summer and autumn.

From the reported effects of late placement of effigies and the continued reduction in the kill of members of the genus Aythya despite recording similar or increased numbers of members of the genus (Table 2), my results support Boag and Lewin's (1980) conclusion that placement of effigies on Pond 1 (Site 5 - Fig. 1) was effective in diminishing the number of waterfowl dying there as the result of bitumen fouling.

Evaluation of the effectiveness of night-lighting of effigies in an attempt to improve their deterring ability cannot be based on the full year of 1979 because of atypical spring weather conditions. Use of data from the summer and autumn indicates that the light system may have increased the effectiveness of the deterring ability of the effigies.

Surveys conducted at the various sites on the lease (Fig. 1) resulted in the recording of 198 avian species (Appendix VIII).

TABLE 9 - Factors affecting the numbers of waterfowl killed in Pond 1 (Site 5 - Fig. 1) and an estimate of their relative importance during the periods April-May, June-July, and August-October.

Factor	Importance Rating[a]		
	Apr-May	June-July	Aug-Oct
Mean number of waterfowl	1	1	1
Effigy placement date[b]	2	-	-
Lighted effigies	3	3	3
Cold weather	2	4	4
High number of rainy days and high amounts of precip.	3	2	2
Fog	3	3	3

[a]Rating code: 1 = very important; 2 = important; 3 = potentially important; 4 = not important.

[b]Effigies assumed to be placed on pond by the end of May, therefore this factor is not relevant during June-July and Aug-Oct.

VI. RECOMMENDATIONS

1. The use of human effigies as the basis of a waterfowl deterrent system be continued on Pond 1 and effected on all other tailings ponds on the Suncor Inc. lease.

2. The light system in effect on Pond 1 be maintained and its usefulness be revaluated during 1980.

3. Research be continued in order to test the correlations reported herein.

4. Placement of heated water into Sites 6 and 7 (Fig. 1) be continued as these areas provide alternate landing areas for waterfowl during the spring, prior to breakup of natural water bodies in the area.

5. Research into other deterring systems, such as some type of sound deterring apparatus, be conducted. Such systems, together with the present system, may improve the efficiency of the total deterring effort.

6. Placement of future tailings ponds should be such that they are as distant as possible from the Athabasca River because of the potential the river has as a navigational cue for migrating waterfowl and its attraction as an open water site in years of late spring breakup of natural waters.

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Appendix I - Desciption of vegetation on Lease 86 prior to development as per Martens and Younkins (1978) in their report 'Reclamation Plan for Great Canadian Oil Sands, Lease 86, 1978 to 2001'.

General Overview

"The vegetation of the lease is composed mainly of a number of forest types with shrub and graminoid fens comprising a minor portion. Forest cover types include jack pine (Pinus banksiana), trembling aspen (Populus tremuloides), white spruce (Picea glauca) and black spruce (Picea mariana), sometimes in association with tamarack (Larix laricina). These species often form mixed stands, due primarily to fire, and thus type nomenclature is somewhat variable (Syncrude Canada Ltd. 1975, Stringer 1976).

Eight physiognomic types were recognized in the study area and include open forest and non-forest vegetation. These types include: 1) Fen (sedge, willow or dwarf birch), 2) Balsam poplar-willow-alder scrub, 3) White spruce-balsam poplar forest, 4) White spruce-aspen forest, 5) Aspen forest, 6) Black spruce forest, 7) Black spruce-tamarack forest-bog complex and 8) Jack pine forest."

Type 1 - Fen (sedge, willow or dwarf birch)

"Wide, shallow drainage systems of the upland plateau are characteristically associated with fen vegetation. A dwarf birch (Betula glandulosa)/sedge (Carex gynocrates)/Sphagnum (Sphagnum palustre) community type represents areas with diffuse impeded drainage on organic terrain. Other prominant species of the community include Labrador Tea (Ledum groenlandicum), horsetail (Equisetum scirpoides), rush (Scirpus paludosus), buckbean (Menyanthes trifoliata) and moss (Dicranum fuscescens). The community is characterized by a hummocky microtopography with moss, and horsetail occurring on the elevated areas and dwarf birch, sedge and rush preferring the wetter depressions. This community type occurs as a frequent, but small inclusion of a generally widespread black spruce dominated forest, also associated mainly with poor drainage and organic terrain.

Drainage systems, more riparian or minerotrophic in nature, contain a willow (Salix spp.)/bluejoint (Calamagrostis canadensis) community type. Other characteristic species include sedge (Carex aquatilis), marsh marigold (Caltha palustris) and moss (Brachythecium rivulare). The community represents marsh habitats within the slightly elevated portions of the plateau or backwater areas on the river floodplain within a larger forested matrix of white spruce, balsam poplar and/or trembling aspen."

Type 2 - Balsam Poplar-Willow-Alder Scrub

"Coarse alluvial materials on the floodplain adjacent to the river are dominated by a Balsam poplar-willow (Salix spp.)- alder (Alnus tenuifolia)/horsetail (Equisetum arvense) community type.

Continued

The community is subject to spring flooding and often has a relatively depauperate understory. Bluebell (Mertensia paniculata), and bluejoint and balsam poplar seedlings occur in slightly less exposed or more stable areas. The habitat is usually adjacent to more mature balsam poplar and/or white spruce communities which also contained evidence of periodical flood deposition."

Type 3 - White Spruce-Balsam Poplar Forest

"Older better drained terraces contain a relatively mature white spruce-balsam poplar forest type, with white spruce increasing in abundance in accordance with terrace age. The vegetation is represented by a white spruce-balsam poplar red osier dogwood (Cornus stolonifera)/horsetail community type. The most mature examples of this community type containing large (about or equal to 40 cm d.b.h.) balsam poplar with white spruce stands occurred on Tar Island prior to mining."

Type 4 - White Spruce-Aspen Forest

"Most of the upland areas of till deposits on the plateau and some eroding valley banks contain a mixed white spruce-aspen forest vegetation.

The upland plateau vegetation is dominated by trembling aspen due to past fires. Small mature stands of nearly pure white spruce occur in isolated pockets which were missed by fires. The slopes of the Athabasca River valley, in addition, have generally been fire-free. This valley vegetation consists mainly of a white spruce-aspen/ blueberry (Vaccinium myrtilloides)/feathermoss (Pleurozium schreberi) community type witha luxuriant understory characterized by a prominant moss carpet. Other prominant species include twinflower (Linnaea borealis), bunchberry (Cornus canadensis), low-bush cranberry (Viburnum edule).

Relatively well-drained till on the upland plateau support aspen dominated forest with white spruce as a subordinate tree. Better drained sites contain a white spruce-aspen/prickly rose (Rosa acicularis)/bunchberry community type. More mesic habitats are represented by a white spruce-aspen/red osier dogwood/horsetail community type. Prominant species of the first type include low-bush cranberry, twinflower, wild sarsaparilla (Aralia nudicaulis) and dwarf raspberry (Rubus pedatus) in the first community type, and low-bush cranberry, wild lily-of-the-valley (Maianthemum canadense) and feather moss (Hylocomium splendens, Pleurozium scherberi) in the second. The presence of white spruce regeneration indicates that both communities are potential white spruce forest types."

Type 5 - Aspen Forest

"Portions of the till plain which have more recently burned and lake shores contain forests dominated by aspen. The vegetation is represented mainly by two community types; aspen/low-bush cranberry/ twinflower, and aspen/low-bush cranberry/dewberry (Rubus pubescens). Important associates include prickly rose, sweet coltsfoot (Petasites palamatus), pea vine (Lathyrus ochroleucus) and bog cranberry

Continued

(Vaccinium vitis-idaea) in the first community type and bluebell, sweet coltsfoot, bunchberry and pea vine in the second. The latter community represents slightly better drained sites and covers a large portion of the aspen dominated vegetation. White birch (Betula papyrifera) and balsam poplar appear as a minor component of the more mesic community especially on lake shores; probably in response to finer textured soils due to slopewash."

Type 6 - Black Spruce Forest

"Black spruce dominated forest vegetation covers a major portion of the lease area in conjunction with organic terrain. The vegetation is composed mainly of two community types; black spruce/Labrador tea/sphagnum, and black spruce/Labrador tea/bog cranberry. The first occurs on poorly drained sites with moss covered hummocks a dominant feature of the understory. Surface water may occur in the small depressions especially in the spring and early summer. Associate species include cloudberry (Rubus chamaemorus), sedge, bog cranberry, moss (Dicranum fucescens) and lichen (Cladina rangiferina).

Slightly better drained sites where till is more prominant are characterized by the second community type and hence, the dominance of bog cranberry in the understory. The sub-hygric nature of the community is indicated by the prominance of buffalo berry (Shepherdia canadensis), shrubby cinquefoil (Potentilla fruticosa), prickly rose, and lichen. Other associates of the community include bunchberry, blueberry, sedge and moss.

Black spruce appears to be reproducing well on both habitats. Some standing snags and charcoal indicate that much of the area was burned, but fire frequency is probably low due to the wet nature of the communities."

Type 7 - Black Spruce-Tamarack Forest-Bog Complex

"Areas intermediate in moisture between black spruce forest and fens contain variably stocked black spruce-tamarack forest. A hummocky ground cover with some standing water characterize this black spruce-tamarack/sedge/sphagnum community type. Other prominant species include dwarf birch, Labrador tea, small bog cranberry (Oxycoccus microcarpus), sedges (Carex spp.) and moss (Dicranum fuscescens, Tomenthypnum nitens). Cool air ponding in these depressions, along with poor drainage and organic soil is probably influencial in this community type and the usually adjacent fens."

Type 8 Jack Pine Forest

"Areas where coarse aeolian material has been deposited within both the till plain and organic veneer contain jack pine forest vegetation. The vegetation is associated with a frequent fire occurrence, due probably to its xeric nature. Charcoal was evident on snags, old stumps and as ground cover.

The most xeric sites contain a jack pine/blueberry/bearberry (Arctostaphylos uva-ursi) community type. Other prominant species include trembling aspen, bedstraw (Galium boreale), sedge (Carex

Continued

capitata), Hooker's oat grass (Helictotricjon hookeri), bastard toad-flax (Geocaulon lividum) and lichen (Cladina mitis).

Narrow bands of aeolian deposits within the large matrix of black spruce forest are also dominated by jack pine. However some sites were quite open with shrubs dominating the community due to recent fires, A jack pine/bog cranberry is postulated for this vegetation.

The assosiate species indicate a relatively xeric habitat, however the presence of black spruce and Labrador tea indicate a potential black spruce community type. Other associates include shrubby cinquefoil, dwarf birch, trembling aspen, wire rush (Junus balticus), Hooker's oat grass and lichen (Cladonia furcata).

Jack pine communities are a common component of the vegetation of the lease area, however they are restricted to coarse aeolian soils which generally occur in narrow strips and thus are quite disjunct."

Appendix II - Description of sites surveyed on the study area (Lease 86) during the period 1977 to 1979.(See Figure 1 for locations of sites and Appendix I for description of vegetation types.)

Site Number	Approximate Size	Nature of Vegetative Cover	Nature of Disturbances	Human Activity
3	90 ha	Types 1, 4, 7, 8, plus revegetation on cleared areas with agronomic grasses.	Clearing of some areas (60 ha); construction of drainage ditch; construction and maintenance of road and pipeline; creation of overburden stockpile; activities concerned with revegetation.	Continuous on roadway; Little on the rest of the site.
4 Pond 1A	65 ha	Less than 5 ha of willows along western edge of site.	Tailings pond; infrequent input of tailings (see text) - functions mainly as a settling pond; throughout 1977 and until June, 1978, a sanitary dump for disposal of office, camp and kitchen wastes was located adjacent to the southeast corner of the pond.	Little.
5 Pond 1	240 ha	None.	Tailings pond with active inflow of tailings; pond surface variably covered with oil and bitumen.	Intermittent to continuous.

Continued

Site Number	Approximate Size	Nature of Vegetative Cover	Nature of Disturbances	Human Activity
6	The Athabasca River for its length opposite the study area plus 150 ha of land area including the south, east and north faces of the Site 5 dyke and parts of the west bank of the river.	Types 2 and 3 plus agronomic grasses and native and non-native trees which have been revegetated on the dyke area.	Construction of dyke and roadways; clearing of some areas at the base of the dyke; construction of a dyke drainage collection system; maintenance of dyke, collection system and roadway; revegetation efforts.	Intermittent to continuous.
7 Water-intake Pond	20 ha	Only a small (2 ha) area of willows on the southwest corner of the pond; pond border covered with grasses.	Pumphouse located on eastern edge of pond; pumping of water from river into pond; recycling of heated water (not oil or chemically polluted) into pond which raises pond temperature such that it rarely freezes even in mid-winter.	Intermittent.
8 Waste-water Pond	20 ha	Willows between road on east edge of pond and the river.	Pond used as collection basin for polluted water from process area of plant; filtration of this water into the river.	Intermittent.

Continued

Site Number	Approximate Size	Nature of Vegetative Cover	Nature of Disturbances	Human Activity
9 General Plant and Mine Site	580 ha	Virtually all cleared; occasional remnant shrub and grass cover.	Areas of intense activity.	Continuous
10 First sewage lagoon	1.5 ha	Pond surrounded by willows which are trimmed each year.	Sewage treatment lagoon; roadway around pond with fence on outside of road; yearly cutting of willows.	Intermittent.
11 Second sewage lagoon	2 ha	Pond surrounded by willows (height to 4 m prior to autumn, 1977).	Sewage treatment lagoon; roadway around pond with fence on outside of road; willows cut down during autumn, 1977.	Intermittent.
12 Lower sewage lagoon	2 ha	Pond surrounded by willows plus some black spruce on west bank; pond surface partially covered by duckweed (<u>Lemna sp</u>.) by mid-July of each year.	Sewage treatment lagoon; roadway around pond with fence on outside of road.	Intermittent.

Continued

Site Number	Approximate Size	Nature of Vegetative Cover	Nature of Disturbances	Human Activity
13	80 ha	Types 2, 3, and 7 plus cleared areas. Also includes a small (4 ha) pond which has some duckweed (Lemna sp.) cover during the summer and autumn.	Relatively undisturbed until the winter of 1978-1979 during which time a 30 ha portion of the northern region was cleared; power line run through area during the spring of 1979.	Intermittent.
14	400 ha	Types 1, 2, 6, 7, and 8 plus cleared area (180 ha).	Clearing underway on south and east sections; overburden and muskeg removal at cleared areas in preparation for mining; road-way construction and maintenance.	Continuous.
15	11 ha	Type 1 surrounding pond.	Site destroyed during 1977 when pond was drained.	
15A	120 ha	None - cleared.	Created in 1978 as the area for a sanitary dump for disposal of office, camp and kitchen wastes.	Intermittent.
16	65 ha	None native; regrowth of Type 1 within an area where muskeg (which had been cleared from Site 9) was dumped; several small ponds, some with sand or mud beaches, have formed within the enclosure.	Following construction of an enclosing overburden dyke within which muskeg was dumped (before 1977), very little disturbance until 1978 when seeding of the dyke was done; during the winter of 1978-1979, muskeg was dumped on the north and east dyke areas.	Little.

Continued

Site Number	Approximate Size	Nature of Vegetative Cover	Nature of Disturbance	Human Activity
17	400 ha	Types 1, 4, 6, 7, and 8.	Road construction plus cutting of survey lines for test core drilling.	Little.

Appendix III - Table from Boag et al.(1977) describing the rate of decay of 5 grebes and 3 ducks placed in Pond 1 (Site 5 - Fig. 1) during the 1975 season.

			STATUS OF		
Species	Time in water(wks)	Position in water	Feathers and skin	Head	Limbs
Grebes[a]	0 (July 30)	3 floating low 2 sank	wet but clean	all 5 below surface	intact
	1 (Aug. 6)	all 5 floating high	partially gone from head and neck	4 floating 1 dropped off	intact
	2 (Aug. 13)	2 floating low 3 sank	largely gone	all 5 dropped off	all dropping off
Ducks[b]	0 (Sept. 12)	all 3 floating low	bitumen soaked	all 3 below surface	intact
	1 (Sept. 19)	all 3 floating high	easily removed	all 3 floating	intact
	2 (Sept. 26)	all 3 floating lower	dropping off	all below surface	intact
	3 (Oct. 2)	all 3 floating low	dropping off	1 head dropped off	intact
	4 (Oct. 9)	all 3 just floating	gone	another head dropped off	disintegrating
	5 (Oct. 16)	all sank	gone	all 3 gone	nearly all gone

a. five western grebes (Aechmophorus occidentalis) fresh frozen after removal from fish nets at Lac La Biche - free of bitumen.

b. two diving ducks, either lesser scaup (Aythya affinis) or ring-necked duck (Aythya collaris)and one common goldeneye (Bucephala clangula), fresh frozen after removal alive from tailings pond - heavily fouled with bitumen.

Appendix IV - Birds recovered from the surface or shorelines of tailings ponds 1 and 1A (Sites 5 and 4 - Fig. 1) during 1977 - 1979. Species latin names are given in Appendix VIII.

Species	Pond 1			Pond 1A		
	1977	1978	1979	1977	1978	1979
Red-necked Grebe		1				
Eared Grebe			2			
White-fronted Goose			1			
Mallard	4	18	65		9	7
Gadwall		4				
Pintail	3	2	10	4	2	1
Green-winged Teal	1	3	13		2	2
Blue-winged Teal	2	1	2	2	1	1
Unidentified Teal	1	1				1
American Wigeon		5	17			
Northern Shoveler	2	10	5	1		2
Canvasback			7			
Aythya spp.	12	5	54	12	5	7
Common Goldeneye	4	2	14		2	1
Bufflehead			1	1		2
Surf Scoter	1		9			
Unidentified Duck	4	3	20		1	
Common Merganser			3			
Red-tailed Hawk		1				
Unidentified Buteo	1					
Ruffed Grouse		1				
Willow Ptarmigan			1			
Sora				1		
American Coot	34	16	13	1	1	2
Killdeer	1	1	1		1	2
Greater Yellowlegs			4			
Lesser Yellowlegs	1		6	1	1	
Baird's Sandpiper	1					
Pectoral Sandpiper			2	1		
Caladris spp.			8	4		
Unidentified Shorebird		1			1	1
Herring Gull				3	1	
California Gull				4	1	
Ring-billed Gull				1		
Horned Lark			4			2
Tree Swallow					1	
Barn Swallow						1
Common Raven		1		3	1	
Water Pipit			1			
Evening Grosbeak			1			
Tree Sparrow	1	3	1			
Unidentified Sparrow			1			
Snow Bunting	2	1	1			
Unidentified Passerine	1			1	1	
Unidentified Bird	1			3		
TOTAL	77	79	270	43	31	33

Appendix V - Mean temperatures for Suncor Inc. Lease, 1977-1979 and the 27-yr mean for Fort McMurray, Alberta (Fig. 1). Temperatures in ^{o}C.

Month / Year	1977	1978	1979	27-Yr.Mean
January	-19.8	-21.4	-22.0	-21.5
February	-2.7	-13.7	-28.8	-16.6
March	-5.1	-7.1	-11.6	-9.4
April	7.4	2.3	-2.4	1.2
May	13.3	10.4	8.0	9.0
June	15.4	14.9	15.5	13.5
July	16.0	16.0	19.2	16.3
August	11.7	14.6	14.3	14.7
September	11.1	10.1	10.8	9.0
October	4.1	5.8	4.9	3.1
November	-8.0	-9.6	-5.0	-8.4
December	-22.3	-21.3	-14.2	-16.9
Year	1.8	0.1	-0.9	-0.5

<u>Appendix VI</u> - Number of days of measurable precipitation and total amounts in mm for the Suncor Inc. Lease (Fig. 1) 1977 - 1979, and the 27-year mean for Fort McMurray, Alberta.

	1977		1978		1979		27-Yr.Mean	
Month	Days	Amount	Days	Amount	Days	Amount	Days	Amount
January	3	10.1	10	17.1	7	5.9	13	21.1
February	3	3.2	3	7.7	18	23.1	11	17.3
March	9	8.9	7	15.5	13	21.9	10	18.3
April	3	21.3	7	62.0	9	118.2	8	20.3
May	10	34.0	6	24.0	10	38.8	9	33.0
June	11	42.6	14	80.6	13	145.5	11	61.5
July	13	53.6	12	26.7	10	50.6	13	73.7
August	11	64.1	18	92.3	15	88.0	12	64.0
September	9	26.6	22	150.0	13	54.9	10	53.1
October	4	21.9	13	28.8	7	25.2	9	24.1
November	11	29.3	11	19.7	5	9.4	12	24.9
December	7	22.1	10	14.4	5	15.0	13	24.1
Year	94	337.7	133	538.8	125	596.5	131	435.4

Appendix VII - Number of observation periods, numbers of waterfowl recorded, and the mean number of waterfowl recorded per month for the period April through October of 1977 - 1979 at both the major sites (Nos. 5, 6, 12, 13, and 16 - Fig. 1) and all sites on the study area (Suncor Inc. Lease, Fort McMurray, Alberta - Fig. 1).

Year	Month	Major Sites			All Sites		
		No. counted	Observ.	Mean No.	No. counted	Observ.	Mean No.
1977	April	6571	55	119.5	6969	144	48.4
	May	6454	128	50.4	8837	344	25.7
	June	3149	88	35.8	3899	232	16.8
	July	3002	87	34.5	3432	229	15.0
	Aug.	2807	96	29.2	3285	259	12.7
	Sept.	3385	83	40.8	3547	218	16.3
	Oct.	981	46	21.3	1044	125	8.4
1978	April	4134	73	56.6	4306	188	22.9
	May	3385	118	28.7	3751	321	11.7
	June	2761	93	29.7	3150	258	12.2
	July	2429	85	28.6	2863	214	13.4
	Aug.	2572	79	32.6	3091	209	14.8
	Sept.	1751	57	30.7	1862	151	12.3
	Oct.	385	44	8.8	430	117	3.7
1979	April	3156	75	42.1	3343	210	15.9
	May	10409	132	78.9	11006	356	30.9
	June	5117	78	65.6	5189	203	25.6
	July	6429	65	98.9	6581	171	38.5
	Aug.	5268	102	51.6	5417	268	20.2
	Sept.	2232	82	27.2	2281	218	10.5
	Oct.	463	37	12.5	494	99	5.0

[illegible]

Appendix VIII - Common and scientific names of 198 species of birds recorded on the study area (Suncor Inc. Lease 86, Fort McMurray, Alberta - Fig. 1) during 1977 - 1979. Dates for earliest and latest sighting of each species are listed. Where only one date appears, the species has only been sighted once. All names conform to those presented in the American Ornithologists' Union Check-list of North American Birds, 5th Edition, 1957, incorporating the changes listed in the Thirty-second Supplement to the A.O.U. Check-list 1973, (Auk 90: 411-419).

SPECIES		EARLIEST SIGHTING	LATEST SIGHTING
Common Loon	Gavia immer	April 25,1977	September 6,1976
Arctic Loon	Gavia adamsii	October 5,1977	
Red-throated Loon	Gavia stellata	May 10,1976	
Western Grebe	Aechmophorus occidentalis	May 10,1979	June 12, 1979
Red-necked Grebe	Podiceps grisegena	April 26,1978	May 30,1976
Horned Grebe	Podiceps auritis	April 24,1977	September 19,1979
Eared Grebe	Podiceps nigricollis	April 27,1978	August 17,1979
Pied-billed Grebe	Podilymbus podiceps	May 6,1978	October 3,1977
Great Blue Heron	Ardea herodias	April 28,1978&79	September 30,1978
American Bittern	Botaurus lentiginosus	May 14,1977	May 27,1976
Whistling Swan	Olor columbianus	May 1,1977	October 13,1978
Canada Goose	Branta canadensis	April 5,1978	October 13,1976
White-fronted Goose	Anser albifrons	April 29,1977	October 4, 1977&78
Snow Goose	Chen caerulescens	April 23, 1977	October 6,1979
Mallard	Anas platyrhynchos	January 19,1979	December 17,1978
Gadwall	Anas strepera	April 27,1978	October 13,1976
Pintail	Anas acuta	April 5,1976	October 25,1979
Green-winged Teal	Anas crecca	April 10,1976	October 27,1976
Blue-winged Teal	Anas discors	April 24,1976	September 25,1976
Cinnamon Teal	Anas cyanoptera	June 19,1979	
American Wigeon	Anas americana	April 19,1977	November 29,1977
Northern Shoveler	Anas clypeata	April 17,1978	October 25,1978
Wood Duck	Aix sponsa	May 18,1977	
Redhead	Aythya americana	April 24,1977	October 18,1977
Ring-necked Duck	Aythya collaris	April 27,1977	October 3,1978
Canvasback	Aythya valisneria	April 23,1977	October 27,1976
Greater Scaup	Aythya marila	June 1,1976	
Lesser Scaup	Aythya affinis	April 19,1977	October 27,1976

SPECIES		EARLIEST SIGHTING	LATEST SIGHTING
Common Goldeneye	Bucephala clangula	April 4,1976&78	October 17,1978
Barrow's Goldeneye	Bucephala islandica	April 19,1978	
Bufflehead	Bucephala albeola	April 19,1977&78	October 13,1976
Oldsquaw	Clangula hyemalis	April 30,1979	October 2,1978
White-winged Scoter	Melanitta deglandi	May 11,1979	July 10,1979
Surf Scoter	Melanitta perspicillata	May 9, 1979	September 15,1977
Ruddy Duck	Oxyura jamaicensis	May 4,1978	October 9,1979
Hooded Merganser	Lophodytes cucullatus	May 18,1979	May 19,1977
Common Merganser	Mergus merganser	January 19,1979	December 28,1977
Red-breasted Merganser	Mergus serrator	April 26,1977	June 1,1979
Goshawk	Accipiter gentilis	April 9,1979	October 10,1976
Sharp-shinned Hawk	Accipiter striatus	April 20,1977	October 6,1979
Cooper's Hawk	Accipiter cooperii	May 8,1976	
Red-tailed Hawk	Buteo jamaicensis	May 9,1977	October 4,1976
Broad-winged Hawk	Buteo platypterus	May 29,1977	
Rough-legged Hawk	Buteo lagopus	April 19,1977	October 18,1977
Golden Eagle	Aquila chrysaetos	April 10,1976	
Bald Eagle	Haliaeetus leucocephalus	April 13,1978	October 14,1977
Marsh Hawk	Circus cyaneus	April 4,1978	October 8,1976
Osprey	Pandion haliaetus	May 10,1976	June 1,1976
Gyrfalcon	Falco rusticolus	May 6,1977	September 22,1977
Peregrine Falcon	Falco peregrinus	April 29,1977	May 31,1979
Merlin	Falco columbarius	April 19,1977	September 30,1979
American Kestrel	Falco sparverius	April 4,1978	October 6,1976&77
Spruce Grouse	Canachites canadensis	April 19,1977	October 17,1977
Ruffed Grouse	Bonasa umbellus	May 13,1979	October 1,1976
Willow Ptarmigan	Lagopus lagopus	April 4,1978	April 27,1979
Sharp-tailed Grouse	Pedioecetes phaisianellus	January 30,1978	October 26,1977
Sandhill Crane	Grus canadensis	April 19,1977	September 8,1979
Sora	Porzana carolina	April 25,1976	August 25,1979
American Coot	Fulica americana	April 19,1977	September 19,1979
Semipalmated Plover	Charadrius semipalmatus	May 10,1978	September 21,1976
Killdeer	Charadrius vociferus	April 7,1976	October 4,1977
American Golden Plover	Pluvialis dominica	May 13,1977	October 5,1977
Black-bellied Plover	Pluvialis squatarola	May 24,1979	October 14,1977
Common Snipe	Capella gallinago	April 20,1977	October 5,1977
Upland Sandpiper	Bartramia longicauda	August 28,1978	
Spotted Sandpiper	Actitis macularia	May 9, 1977&78	September 22,1978
Solitary Sandpiper	Tringa solitaria	May 13,1976	September 2,1976
Greater Yellowlegs	Tringa melanoleuca	April 30,1977	October 17,1978
Lesser Yellowlegs	Tringa flavipes	April 18,1978	October 18,1977
Willet	Catoptrophorous semipalmatus	May 25,1976	
Ruddy Turnstone	Arenaria interpres	May 25,1978	August 23,1977
Sanderling	Caladris alba	May 25,1976	September 30,1979
Semipalmated Sandpiper	Caladris pusilla	May 13,1977	September 8,1977
Least Sandpiper	Caladris minutilla	May 7,1977	September 8,1979
White-rumped Sandpiper	Caladris fusicollis	May 26,1977	September 17,1977
Baird's Sandpiper	Caladris bairdii	May 7,1977	September 21,1977

SPECIES		EARLIEST SIGHTING	LATEST SIGHTING
Pectoral Sandpiper	Caladris melanotos	May 8,1978	October 24,1979
Dunlin	Caladris alpina	June 3,1976	
Short-billed Dowitcher	Limnodromus griseus	May 8,1977	August 23,1976
Long-billed Dowitcher	Limnodromus scolopaceus	May 8,1977	October 7,1976
Stilt Sandpiper	Micropalama himantopus	May 15,1977	September 13,1976
Buff-breasted Sandpiper	Tryngites subruficollis	May 28,1978	August 26,1978
Hudsonian Godwit	Limosa haemastica	May 25,1978	September 28,1976
American Avocet	Recurvirostra americana	May 2,1977	May 6,1977
Wilson's Phalarope	Steganopus tricolor	May 2,1977	August 29,1979
Northern Phalarope	Lobipes lobatus	May 22,1976	September 1,1976
Glaucous Gull	Larus hyperboreus	April 26,1979	June 1,1979
Herring Gull	Larus argentatus	April 17,1978&79	October 25,1979
California Gull	Larus californicus	April 9,1979	October 25,1979
Ring-billed Gull	Larus delawarensis	April 8,1976	October 25,1979
Mew Gull	Larus canus	April 30,1978	August 2,1979
Franklin's Gull	Larus pipixcan	April 21,1978	August 16,1979
Bonaparte's Gull	Larus philadelphia	April 17,1978	October 5,1977
Common Tern	Sterna hirundo	May 9,1977	August 6,1979
Caspian Tern	Hydroprogne caspia	June 20,1976	
Black Tern	Chlidonias niger	May 2,1978	August 24,1979
Mourning Dove	Zenaida macroura	May 23,1978	June 30,1976
Great Horned Owl	Bubo virginianus	May 2,1979	October 4,1976
Snowy Owl	Nyctea scandiaca	April 11,1976	November 15,1977
Hawk Owl	Surnia ulula	January 10,1979	June 15,1979
Short-eared Owl	Asio flammeus	April 19,1977	October 5,1976
Common Nighthawk	Chordeiles minor	May 24,1976	August 21,1979
Belted Kingfisher	Megaceryle alcyon	May 1,1977	October 4,1977
Common Flicker	Colaptes auratus	April 22,1976	October 5,1976
Pileated Woodpecker	Dryocopus pileatus	May 14,1977	June 17,1976
Yellow-bellied Sapsucker	Sphyrapicus varius	April 25,1977	September 15,1976
Hairy Woodpecker	Picoides villosus	January 25,1979	October 4,1978
Downy Woodpecker	Picoides pubescens	January 19,1979	September 28,1977
Black-backed Three-toed Woodpecker	Picoides arcticus	May 6,1977	
Northern Three-toed Woodpecker	Picoides tridactylus	May 13,1977	September 21,1978
Eastern Kingbird	Tyrannus tyrannus	May 23,1978	September 8,1976&79
Eastern Phoebe	Sayornis phoebe	April 30,1977&78	August 23,1977
Say's Phoebe	Sayornis saya	May 3,1978	August 2,1976
Yellow-bellied Flycatcher	Empidonax flaviventris	May 24,1978	August 22,1977
Alder Flycatcher	Empidonax alnorum	May 25,1977	August 22,1976
Least Flycatcher	Empidonax minimus	May 12,1977	August 12,1977
Western Wood Pewee	Contopus sordidulus	May 25,1977&79	July 23,1979
Olive-sided Flycatcher	Nuttallornis borealis	July 7,1977	
Horned Lark	Eremophila alpestris	April 26,1978	October 17,1977
Tree Swallow	Iridoprocne bicolor	April 22,1977	September 27,1976
Bank Swallow	Riparia riparia	May 17,1978	August 8,1977
Barn Swallow	Hirundo rustica	April 30,1978	September 21,1976
Cliff Swallow	Petrochelidon pyrrhonota	May 3,1978	August 27,1977
Gray Jay	Perisoreus canadensis	January 12,1979	December 17,1978

SPECIES		EARLIEST SIGHTING	LATEST SIGHTING
Blue Jay	Cyanocitta cristata	April 8,1979	November 6,1978
Black-billed Magpie	Pica pica	January 15,1979	December 19,1979
Common Raven	Corvus corax	January 10,1979	December 28,1977
Common Crow	Corvus brachyrhynchos	April 5,1976	October 4,1977&78
Black-capped Chickadee	Parus atricapillus	January 15,1979	October 27,1976
Boreal Chickadee	Parus hudsonicus	April 21,1978	October 12,1977
Red-breasted Nuthatch	Sitta canadensis	May 12,1976	August 29,1977
Long-billed Marsh Wren	Cistothorus palustris	May 26,1977	July 13,1976
American Robin	Turdus migratorius	April 16,1976	October 18,1977
Hermit Thrush	Catharus guttatus	May 6,1977	October 6,1976
Swainson's Thrush	Catharus ustulatus	May 18,1976	September 28,1977
Mountain Bluebird	Sialia currucoides	April 4,1978	September 19,1978
Ruby-crowned Kinglet	Regulus calendula	April 26,1977	August 2,1978
Water Pipit	Anthus spinoletta	April 26,1977	October 24,1979
Bohemian Waxwing	Bombycilla garrulus	April 20,1977	October 14,1978
Cedar Waxwing	Bombycilla cedrorum	June 12,1978	September 14,1976
Northern Shrike	Lanius excubitor	March 23,1979	October 8,1976
Common Starling	Sturnus vulgaris	March 23,1979	December 19,1979
Solitary Vireo	Vireo solitarius	July 29,1977	August 24,1977
Red-eyed Vireo	Vireo olivaceus	May 14,1977	September 6,1976
Philadelphia Vireo	Vireo philadelphicus	May 20,1977	August 15,1976
Warbling Vireo	Vireo gilvus	May 20,1976	August 9,1976
Black and White Warbler	Mniotilta varia	May 12,1976	August 24,1977
Tennessee Warbler	Vermivora peregrina	May 8,1977	September 10,1976
Orange-crowned Warbler	Vermivora celata	May 10,1977	August 12,1977
Yellow Warbler	Dendroica petechia	May 12,1977	September 16,1976
Magnolia Warbler	Dendroica magnolia	May 23,1978&79	September 1,1978
Cape May Warbler	Dendroica tigrina	May 28,1979	
Yellow-rumped Warbler	Dendroica coronata	May 2,1977	September 29,1977
Black-throated Green Warbler	Dendroica virens	May 25,1979	August 24,1977
Bay-breasted Warbler	Dendroica castanea	May 28,1979	July 7,1977
Blackpoll Warbler	Dendroica striata	May 14,1977	May 28,1979
Palm Warbler	Dendroica palmarum	May 13,1976	October 4,1977
Ovenbird	Seiurus aurocapillus	May 19,1978	July 6,1979
Northern Waterthrush	Seiurus noveboracensis	May 10,1977	September 1,1976
Mourning Warbler	Oporornis philadelphia	May 27,1976&77	August 12,1977
Common Yellowthroat	Geothlypis trichas	May 25,1977&78	September 1,1976
Wilson's Warbler	Wilsonia pusilla	May 23,1978	September 19,1976
Canada Warbler	Wilsonia canadensis	May 25,1977	September 20,1976
American Redstart	Setophaga ruticilla	May 17,1976	September 2,1976
House Sparrow	Passer domesticus	January 10,1979	December 19,1979
Western Meadowlark	Sturnella neglecta	May 2,1977	July 21,1977
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	May 1,1979	September 15,1979
Red-winged Blackbird	Agelaius phoeniceus	April 9,1976	August 29,1977
Rusty Blackbird	Euphagus carolinus	April 29,1977	October 24,1979
Brewer's Blackbird	Euphagus cyanocephalus	April 22,1977	October 12,1977
Common Grackle	Quiscalus quiscula	April 22,1977	October 8,1979
Brown-headed Cowbird	Molothrus ater	May 4,1977	September 9,1976

SPECIES		EARLIEST SIGHTING	LATEST SIGHTING
Western Tanager	Piranga ludoviciana	May 15,1977	August 16,1979
Rose-breasted Grosbeak	Pheucticus ludovicianus	May 12,1977	September 6,1976
Evening Grosbeak	Hesperiphona vespertina	May 3,1976	October 11,1976
Purple Finch	Carpodacus purpureus	April 21,1977	October 1,1976
Pine Grosbeak	Pinicola enucleator	January 25,1979	December 17,1978
Common Redpoll	Carduelis flammea	January 10,1979	December 28,1977
Pine Siskin	Carduelis pinus	June 14,1977	September 13,1977
American Goldfinch	Carduelis tristis	June 6,1977	August 3,1976
White-winged Crossbill	Loxia leucoptera	October 26,1977	
Savannah Sparrow	Passerculus sandwichensis	May 3,1978	September 25,1976
LeConte's Sparrow	Ammospiza leconteii	May 10,1977	August 31,1976
Sharp-tailed Sparrow	Ammospiza caudacuta	June 11,1979	September 7,1976
Vesper Sparrow	Pooecetes gramineus	June 1,1979	July 20,1977
Dark-eyed Junco	Junco hyemalis	April 10,1976	October 23,1979
Tree Sparrow	Spizella arborea	April 27,1978	October 24,1979
Chipping Sparrow	Spizella passerina	May 7,1977	September 2,1976
Clay-colored Sparrow	Spizella pallida	May 14,1977	August 8,1976
Harris's Sparrow	Zonotrichia querula	May 9,1977	October 12,1977
White-crowned Sparrow	Zonotrichia leucophrys	April 28,1978	September 30,1977
White-throated Sparrow	Zonotrichia albicollis	May 3,1976	September 30,1979
Fox Sparrow	Passerella iliaca	April 23,1976	October 12,1977
Lincoln's Sparrow	Melospiza lincolnii	May 13,1977	September 12,1977
Swamp Sparrow	Melospiza georgiana	May 14,1977	September 30,1976
Song Sparrow	Melospiza melodia	April 20,1976	October 8,1976
Lapland Longspur	Calcarius lapponicus	April 28, 1976	October 6,1976&79
Snow Bunting	Plectrophenax nivalis	January 19,1979	November 18,1979

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